

# Enhancing Students' Critical Reading Fluency, Engagement and Self-Efficacy using Self-Referenced Learning Analytics Dashboard Visualizations

Christin JONATHAN<sup>a\*</sup>, Jennifer Pei-Ling TAN<sup>a</sup>, Elizabeth KOH<sup>a</sup>, Imelda CALEON<sup>a</sup> & Siu Hua TAY<sup>b</sup>

<sup>a</sup>*National Institute of Education, Nanyang Technological University, Singapore*

<sup>b</sup>*Educational Technology Division, Ministry of Education, Singapore*

\*christin.jonathan@nie.edu.sg

**Abstract:** Although learning analytics (LA) dashboard visualizations are increasingly being used to provide feedback to students, literature on the effectiveness of LA dashboards has been inconclusive. To address this, a LA student dashboard visualizing students' latest data against their own data from previous weeks (i.e., self-referenced data) was designed – informed by Fredrickson's (2004) broaden-and-build theory, as well as studies highlighting personal best goals (Martin & Elliot, 2016) and the negative effects of peer comparisons (Corrin & de Barba, 2014). The self-referenced LA student dashboard was implemented and evaluated in a Singapore Secondary school as part of a larger study, WiREAD. This paper reports on the quantitative impact of the WiREAD self-referenced LA dashboard visualizations on 15-year-old students' critical reading fluency, cognitive reading engagement, and English language (EL) self-efficacy, as well as students' qualitative feedback on the usefulness and shortcomings of the LA dashboard.

**Keywords:** Learning Analytics, student dashboards, English language, critical reading skills

## 1. Introduction

Learning analytics (LA) dashboards are increasingly being employed to provide timely, dynamic, and visual online formative feedback to support teaching and learning (Verbert, Duval, Klerkx, Govaerts, & Santos, 2013) and make learning visible through the use of visualizations (Lockyer, Heathcote, & Dawson, 2013). Research studies in the field of LA have highlighted the potential of LA student dashboards in enhancing students' motivation and engagement (Verbert et al., 2013; Wise, Zhao, & Hausknecht, 2014), as well as improving learning behaviours and academic performance (Arnold & Pistilli, 2012). However, some have suggested that LA dashboards have resulted in more frequent but not higher quality feedback (Pardo et al., 2016; Tanes, Arnold, King, & Remnet, 2011) and can even be detrimental for learning (Corrin & de Barba, 2014). These contradictory illustrations of the effects of LA dashboards on learning emphasize the need for the purposeful and empirically-informed design of LA dashboards.

The use of LA student dashboards visualizing peer comparisons such as the class average can dampen the engagement of students above the class average (Corrin & de Barba, 2014) and be perceived as discouraging and stressful (Wise et al., 2014; Tan, Koh, Jonathan, & Yang, 2017). In addition, personal best goals have recently been given prominence as strong predictors of academic motivation and engagement (Martin & Elliot, 2016). According to Fredrickson's (2004) broaden-and-build theory, positive emotions serve to broaden mindsets and responses that build up lasting personal resources associated with greater student engagement and resilience in school settings (Reschly, Huebner, Appleton, & Antaramian, 2008). Taken together, these findings suggest that LA student dashboards should be designed to be more intrinsically motivating through the use of an individual's own learning data as the comparison for their performance (i.e., self-referenced data).

To this end, a self-referenced LA student dashboard visualizing students' learning data from past weeks against their latest data was designed and implemented as part of a larger ongoing study — WiREAD. This paper reports on the effectiveness of the WiREAD self-referenced LA student dashboard in enhancing 15-year-old students' critical reading fluency, cognitive reading engagement and EL/reading self-efficacy in English language in a Singapore Secondary school.

## 2. The Current Study

WiREAD is a web-based collaborative critical reading and LA environment designed with the aim of fostering students' 21C literacies in EL, particularly their critical reading development. Drawing from theorizations of new literacies (Jewitt & Kress, 2003; New London Group, 1996) that view literacy as “increasingly multiple, multimodal and mediated through new technology” (Burnett, Davies, Merchant, & Rowsell, 2014, p. 1), our conceptualization of 21C literacies emphasizes the importance of critical reading as a key component of language and literacy skills required for individuals to thrive in modern knowledge-based societies. Through WiREAD's collaborative critical reading space, multimodal texts around social, moral, and/or ethical dilemmas were uploaded for students to read and critique with their classmates during and beyond formal class time (see Tan, et al., 2017). Students' activity on WiREAD was captured and visualized to them through the LA dashboard, along with other relevant learning data. We elaborate on the components of the LA student dashboard in the following section.

### 2.1 Self-referenced LA Student Dashboard Visualizations

The WiREAD LA student dashboard was designed to improve learning outcomes by enabling students to track their critical reading engagement and progress, and change their learning behaviours and strategies. Students were given access to visual, dynamic, and timely formative feedback around their discourse, dispositional, and social network analytics (Ferguson & Buckingham Shum, 2012) as well as achievement data. Building on a previous version of the LA dashboard (see Tan et al., 2017), the visualizations were modified in this iteration to show students their latest available learning data compared against their past data (i.e., self-referenced data). This self-referenced LA student dashboard is the focus of this paper, and comprises the following 5 components (Figure 1):

- **My Comments and Replies Data:** discourse-related learning data visualising students' latest and previous week's frequency and length of comments and replies posted on each text, alongside the number of peer-awarded 'likes' and teacher-awarded motivational badges received;
- **My Critical Lens and Comment Types Usage Data:** discourse-related learning data visualising students' latest and previous week's frequency of the critical lens and comment types that students had to tag to each of their comments/replies for each text;
- **My WiREAD Social Learning Network Map:** social network maps visualising the position and influence of students in the WiREAD learning network for each text (only the names of people the student has discussed the texts online with are visible);
- **My Learning Attitudes and 21CC Profile:** dispositional learning data visualising students' responses on self-report questionnaires measuring 21C learning dispositions at the start and end of the trial
- **My Achievement Data:** achievement data visualising students' reading scores from school-based EL assessments that occurred before and during the trial.

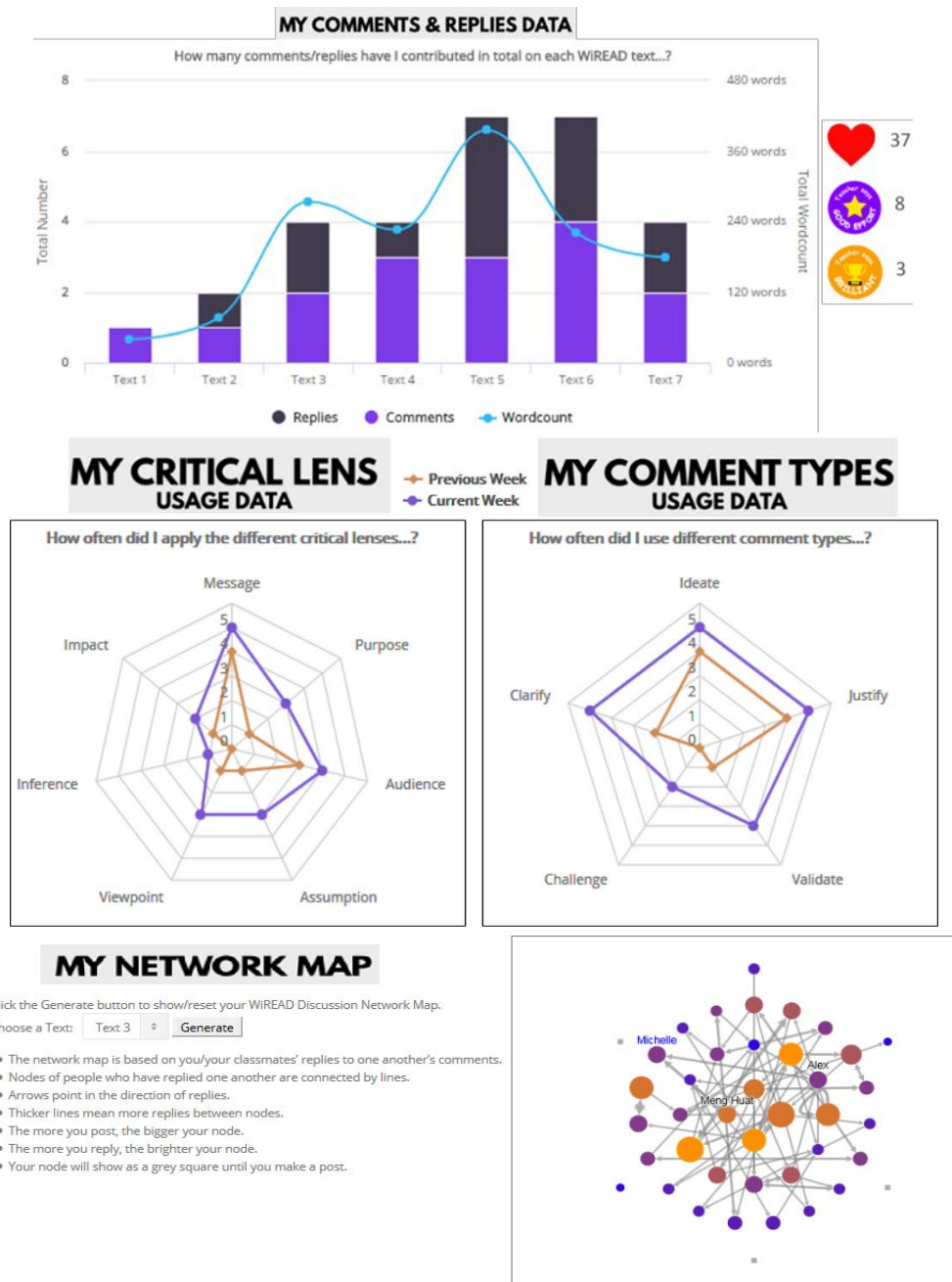


Figure 1. Self-referenced LA dashboard visualizations (selected only)

### 3. Methods

A mixed methods research design was used to gather quantitative and qualitative data pre- and post-trial. The sample is made up of 101 students from 7 Secondary 3 (Grade 9) classes who had been randomly assigned the self-referenced LA dashboard during a 10-week trial in Singapore.

Critical reading fluency was measured using an objective critical reading test designed and graded by teachers to assess students' range of critical reading sub-skills demonstrated in their answers (e.g., agreement/validation, disagreement/challenge, justification). A self-reported questionnaire was used to measure (i) cognitive reading engagement using a 4-item scale adapted from Wolters' (2004) learning strategies questionnaire (see Caleon et al., 2015), and (ii) EL/reading self-efficacy measured by a 10-item EL academic self-concept scale (adapted from Rosenberg, 1989) and a 13-item critical reading ability scale. These scales demonstrated good internal reliability, with Cronbach alpha scores ranging from 0.84 to 0.96. Sample items of each scale are listed below.

(i) Cognitive reading engagement (7-point Likert scale, 1-strongly disagree to 7-strongly agree): *In EL classes, I try to relate what I'm learning to what I already know.*

(ii) EL self-efficacy:

- EL academic self-concept (7-point Likert scale, 1-strongly disagree to 7-strongly agree): *I feel that I am able to do tasks as well as most other classmates.*
- Critical reading ability (7-point Likert scale, 1-never true to 7-always true): *I am capable of examining the assumptions underlying the EL texts I read.*

Qualitative data was also collected through (1) qualitative feedback forms asking students to elaborate on the usefulness and shortcomings of the self-referenced LA dashboard and (2) student focus groups comprising 8-10 students per focus group per participant class.

## 4. Results

### 4.1 Quantitative Findings

Analysis of the quantitative data using paired-sample t-tests revealed the effectiveness of the self-referenced LA dashboard as shown by the statistically significant pre- and post-trial improvements in students' (i) critical reading fluency scores ( $t=2.72, p<.01, d=0.22$ ), and self-reported (ii) cognitive reading engagement ( $t=2.81, p<.01, d=0.27$ ), and (iii) EL/reading self-efficacy, comprising the subscales of EL academic self-concept ( $t = 2.19, p<.05, d=0.15$ ) and critical reading ability ( $t=3.27, p<.01, d=0.32$ ). The descriptive data, t-test results, and effect sizes are reported in Table 1.

Table 1: Descriptive data, paired-samples t-test results and effect sizes.

Variables	Pre-test Mean (SD)	Post-test Mean (SD)	<i>t</i>	cohen's <i>d</i> (Effect size)
Critical reading fluency	10.23 (3.96)	11.18 (4.66)	2.72**	0.22 (s)
Cognitive reading engagement	4.95 (1.07)	5.22 (0.90)	2.81**	0.27 (m)
EL academic self-concept	4.39 (1.10)	4.57 (1.17)	2.19*	0.15 (s)
Critical reading ability	4.26 (1.09)	4.60 (1.01)	3.27**	0.32 (m)

\* $p<.05$ , \*\* $p<.01$ . SD = Standard Deviation.

### 4.2 Qualitative Feedback

Qualitative data from feedback forms and focus group discussions provided a more nuanced understanding of the usefulness of the self-referenced LA dashboard as experienced by the students, as well as the shortcomings associated with the use of such LA affordances.

#### 4.2.1 Perceived Benefits

Students' qualitative accounts of the usefulness of the self-referenced LA dashboard visualizations for their learning highlighted three benefits: 1) creating greater self-awareness, 2) encouraging deeper learning engagement, and 3) promoting the development of critical reading fluency.

Students frequently described the LA dashboard visualizations as useful in terms of helping them “*track [their] improvement*” and become more “*aware of their strength and weakness*”: “*It is useful in a way that it provides a clear view of my progress and my current standing in terms of different components such as visual text and narrative text. It highlights where my strengths and weaknesses are and where I should focus and try to improve on*” (Student 3r729). Similarly, Student 3r141 stated that “*My Critical Lens/Comment Types... allows me to know which critical lenses I have not used. Without it, I am sure that I would be using the same critical lens repeatedly.*”

Repeatedly heard among the students were comments about how the LA dashboard visualizations “*motivated*” and “*encouraged*” them to deepen their critical reading engagement: “*Having more likes and motivational badges also motivate me to put in more effort into WiREAD to make me use more effort into replying and commenting*” (Student 3r713). Echoing this view, Student

3r527 stated that *“My Critical Lens/Comment Types... encouraged me to spread out and try different critical lenses and comment types for a more comprehensive view of a topic.”*

Many of the students recognised that their learning data, particularly their Critical Lens and Comment Types Usage data, could help in *“improving [their] quality of responses”*: *“I found My Critical Lens/Comment Types presented in My Learning Dashboard very useful because I can see the frequency of me using different critical lens and comment types in the texts I have read. Then I will try to use a critical lens or comment types that I did not use very often next time. By trying different critical lens and comment types, I can develop my reading skills”* (Student 3r723).

#### 4.2.2 Perceived Shortcomings

Three key shortcomings of the LA dashboard emerged from students' qualitative feedback: 1) desire for more system/expert-generated quality indicators, 2) preference for 'live' data indicators, and 3) an emergent understanding of the influence of dispositional factors and social learning connections on learning.

Teacher Motivational Badges were implemented on WiREAD instead of the formal grading of comments and replies and were used by some students *“to check how well written [their] comments are”*. However, some students called for more quality-based indicators of critical reading, stressing that *“quality is over “quantity”*: *“I think the My Comments/Replies section does not really help as it only provides information of how many replies and comments I have made and not the quality of my answers”* (Student 3r132).

Many expressed a strong preference for 'live' indicators, describing 'My Learning Attitudes and 21CC Profile' and 'My Achievement Data' visualizations as *“a one-time check”* that *“does not reflect the improvements [they] had made”*: *“the 21CC Profile was created based on a 1 time survey and even if we feel different, we are unable to change it and it just remains permanent. Hence, I feel that we should be able to change it every month to see if there is a difference”* (Student 3r714).

Most students displayed an emergent understanding of the significance of dispositional factors and social learning connections as they *“do not see why [their] interactions with other users has any impact on [their] learning”* and felt that data on learning attitudes and 21CC profiles *“does not have any effect on [their] learning”*. Views such as *“my WiREAD Network Map will help me to interact more with different group of people and hence stimulates me to think critically before giving my comments”* and *“the 21CC Profile graph as it is applicable in real life”* were scarce.

## 5. Discussion and Conclusion

The qualitative findings around the benefits of self-referenced LA visualizations provide support for the quantitative findings reported earlier, particularly in terms of enhancing students' critical reading fluency and engagement. Students' comments about the LA visualizations contributing to increased self-awareness and engagement are in line with research on the associations between greater self-awareness and self-regulated learning strategies (Zimmerman & Martinez-Pons, 1988), emphasizing the potential of LA in making learning visible (Lockyer et al., 2013). Students' emergent understanding of the influence of dispositional factors and social learning connections on learning intensifies the need for schools to give greater emphasis in developing these literacies and dispositions in students, given their influence on learning and life outcomes (Christakis & Fowler, 2009; Levin, 2012). The other shortcomings described by students will be taken into account in the design of future LA visualizations to provide more effective feedback.

Since the self-referenced LA student dashboard was randomly assigned to students within classes and across 7 classes, the benefits and shortcomings of using self-referenced LA dashboard visualizations reported in this paper are generalizable to some extent. However, we caution that the results should be interpreted within the context and sample – of one ability group in one Singapore secondary school. We acknowledge that the study can be further strengthened through the use of a quasi-experimental design with a control group as well as by evaluating the self-referenced LA visualizations against other types of LA visualizations. Nevertheless, though the findings presented here, we hope to provide some insight on the design and impact of LA dashboards in the Asian

educational context and contribute to better designed LA dashboards to maximize the learning potential of diverse students.

## Acknowledgements

This paper refers to data and analysis from the research project NRF2013-EDU001-EL019, funded by the Singapore National Research Foundation, eduLab Research Program. The views expressed in this paper are the authors' and do not necessarily represent the views of the National Institute of Education, Singapore.

## References

- Arnold, K. E., & Pistilli, M. D. (2012, April). Course signals at Purdue: using learning analytics to increase student success. In *Proceedings of the 2nd international conference on learning analytics and knowledge* (pp. 267-270). ACM.
- Burnett, C., Davies, J., Merchant, G., & Rowsell, J. (Eds.). (2014). *New literacies around the globe: Policy and pedagogy*. New York: Routledge.
- Caleon, I. S., Wui, M. G. L., Tan, J. P-L., Chiam, C. L., Soon, T. C., & King, R. B. (2015). Cross-cultural validation of the Academic Motivation Scale: A Singapore investigation. *Child Indicators Research*, 8(4), 925-942.
- Christakis, N. A., & Fowler, J. H. (2009). *Connected: The surprising power of our social networks and how they shape our lives*. Little, Brown.
- Corrin, L., & de Barba, P. (2014). Exploring students' interpretation of feedback delivered through learning analytics dashboards. In *Proceedings of the ascilite 2014 conference* (pp. 629-633).
- Ferguson, R., & Buckingham Shum, S. (2012). Social learning analytics: Five approaches. *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (LAK '12)*, 29 April–2 May 2012, Vancouver, BC, Canada (pp. 23–33). New York: ACM.
- Fredrickson, B. L. (2004). The broaden-and-build theory of positive emotions. *Philosophical transactions-royal society of london series b biological sciences*, 1367-1378.
- Jewitt, C., & Kress, G. R. (Eds.). (2003). *Multimodal literacy*. New York: Lang.
- Levin, H. M. (2012). More than just test scores. *Prospects*, 42(3), 269-284.
- Lockyer, L., Heathcote, E., & Dawson, S. (2013). Informing pedagogical action: Aligning learning analytics with learning design. *American Behavioral Scientist*, 57(10), 1439-1459.
- Martin, A. J., & Elliot, A. J. (2016). The role of personal best (PB) and dichotomous achievement goals in students' academic motivation and engagement: a longitudinal investigation. *Educational Psychology*, 36(7), 1285-1302.
- New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60–93.
- Pardo, A., Mirriahi, N., Martinez-Maldonado, R., Jovanovic, J., Dawson, S., & Gašević, D. (2016, April). Generating actionable predictive models of academic performance. In *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge* (pp. 474-478). ACM.
- Reschly, A. L., Huebner, E. S., Appleton, J. J., & Antaramian, S. (2008). Engagement as flourishing: The contribution of positive emotions and coping to adolescents' engagement at school and with learning. *Psychology In The Schools*, 45(5), 419-431. doi:10.1002/pits.20306
- Rosenberg, M. (1989). *Society and the Adolescent Self-Image* (Rev. ed.). Middletown, CT: Wesleyan University Press.
- Tan, J. P-L., Koh, E., Jonathan, C. R., & Yang, S. (2017). Learner Dashboards a Double-Edged Sword? Students' Sense-Making of a Collaborative Critical Reading and Learning Analytics Environment for Fostering 21st Century Literacies. *Journal of Learning Analytics*, 4(1), 117-140.
- Tanes, Z., Arnold, K. E., King, A. S., & Remnet, M. A. (2011). Using Signals for appropriate feedback: Perceptions and practices. *Computers & Education*, 57(4), 2414-2422.
- Verbert, K., Duval, E., Klerkx, J., Govaerts, S., & Santos, J. L. (2013). Learning analytics dashboard applications. *American Behavioral Scientist*, 0002764213479363.
- Wise, A. F., Zhao, Y., & Hausknecht, S. N. (2014). Learning analytics for online discussions: Embedded and extracted approaches. *Journal of Learning Analytics*, 1(2), 48-71.
- Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. *Journal of educational psychology*, 96(2), 236.
- Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of educational psychology*, 80(3), 284.