So, H. J. et al. (Eds.) (2020). Proceedings of the 28th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Learning Analytics of Critical Reading Activity: Reading *Hayavadana* during Lockdown

Rwitajit MAJUMDAR[a*], Geetha BAKILAPADAVU[b] , Reek MAJUMDER[c] , Mei-Rong Alice CHEN[a], Brendan FLANAGAN[a] & Hiroaki OGATA[a]
[a]Academic Center for Computing and Media Studies, Kyoto University, Japan
[b]Department of Humanities and Social Science, BITS Pilani Goa Campus, India
[c]School of Computing, Clemson University, USA
*dr.rwito@gmail.com

Abstract: Investigating learning behaviors in a humanities course using learning analytics techniques is underrepresented in literature. A *Critical Analysis of Literature and Cinema* course was selected as a context. The course was offered for more than 10 years by the instructor in a face-to-face classroom mode. However, this time the context was unique as the classroom-based interactive activities were rapidly migrated to online sessions due to the COVID-19 pandemic related lockdown. Under such a circumstance, BookRoll, a learning analytics enhanced eBook platform supported the critical reading activity online. Students (n=22 out of the 50 registered) accessed *Hayavadana,* an Indian play titled *Hayavadana* uploaded on BookRoll and attempted to identify performative elements and cultural references in the text and highlight them. In this study, we analyze learner's reading logs gathered in the learning record store linked to BookRoll during that activity. Based on learner's online reading engagement from their clickstream interactions and time spent for them, four readers' profiles were defined; *Effortful, Strategic, Wanderers* and *Check-out*. We illustrate the content navigation and annotation behavior of each of those profiles. This study aims to initiate further discussion related to the application of learning analytics in humanities courses both to enhance the teaching and learning experiences by the use of interactive learning dashboards that was used to probe into the learning behaviors of the students.

Keywords: Learning Analytics, Humanities Course, BookRoll, Critical Reading Activity, Process Mining, Hayavadana

1. Background and Motivation

Learning analytics as a domain has evolved over the last decade to apply various computational techniques to collect, analyze and understand data related to teaching-learning experiences and thereby enhance them. While there are many studies which look at the different applications of Learning Analytics (LA) in STEM domains (Sergis et al. 2019), the focus on humanities courses at the university level is still limited. In this pilot attempt, we investigate student's behaviors at a critical literature analysis course during their specific activity to analyze an act of a play. The play Hayavadana by Girish Karnad was chosen for the activity and it was done online using BookRoll, a Learning Analytics enhanced e-book-based learning platform. Learning traces are automatically collected as interaction logs based on the reader's actions (navigation by clicking on buttons, annotating by using highlighting functions, etc) which could then be analyzed. Understanding the process of development of critical thinking skills is an important research aspect (Douglas, 2000). It can potentially help to inform teachers to design learning activities to support their students and also system developers to create technology assistance to orchestrate those activities.

Hence, in such an authentic natural learning setting, we investigate the following two research questions:

1. What are the reading behaviors of the learners given the critical reading task in terms of interactions within the e-content and the time spent on that task?

2. What are the different profiles of learners based on the distribution of the interactions and time spent with the e-content, and what are the characteristics in terms of content navigation and annotation patterns during the critical analysis task?

The article is organized in the following sections. Section 2 looks at the related works and provides the foundation of the study. Section 3 illustrates the context, learning task and the research methods. Section 4 presents the results of the analysis. Section 5 ends with the discussion and conclusion of the study.

2. Related work and foundation of the study

2.1 Critical reading activities

Critical reading is an active, in-depth reading of a text that calls forth a deeper engagement with the text. Such an activity requires cognitive tasks such as comprehending, analyzing, evaluating, interpreting and synthesizing. A critical reading activity requires one to highlight important ideas in the text, relate it to one's personal experiences, pose questions and think about answers for such questions, look into the patterns within the text, and make connections with other texts. In certain contexts, it would involve identifying socio-cultural contexts and reading through them. Critical reading enables the reader to read not only the explicit meanings but the layered and the implicit meanings as well. Over and above, critical reading enhances one's ability for task-focused thinking. Critical thinking is reasonable, reflective thinking, focusing on a task, people or belief (Ennis, 1993). Also referred to as 'good thinking', 'thinking well' and 'smart thinking' - it enables one to identify questions worth pursuing through self-directed search and interrogation of knowledge (Pithers, 2000).

From the humanities education standpoint, developing critical reading skills is crucial. One of the essential values of Humanities is identified as critical thinking (Holm et.al. 2015). Especially so in the case of courses that deal with cultural texts including narrative arts. While understanding subjective experiences embedded in the texts and relating with them are important, deciphering the layered meanings is also equally significant. Developing critical reading skills enable one to do all the above tasks for a much-enriched meaning-making process.

In the context of reading a cultural text, it is imperative for the reader to be able to identify various pointers (references) that bring the cultural context to the fore. It is well established that the reader's prior exposure to the cultural context enhances the reader's relatability to the text. The instructor, through her classroom experiences and reflections, had identified the role of annotation in making the reader dive deeper into the text. In this particular module being discussed, the text chosen is loaded in its cultural references and certain traditional theatrical conventions as performative elements. Hence, the instructor identified the learning task to annotate cultural references and performative elements. Learning logs were gathered for analytics during that task.

2.2 Learning analytics and critical reading activity

Critical reading from the perspective of critical thinking by the learners was studied using a technology environment at the school level in Singapore (Tan, Yang, Koh & Jonathan, 2016; Jonathan et al. 2017). The study used a collaborative environment and a LA dashboard for supporting critical reading activities at the school level. User acceptance of the innovation and its associated usability issues were its main focus. Our earlier studies with university level students proposed a specific in-class pedagogical model and studied their reading behaviors while they were comprehending English as a foreign language (Chen et al. 2019). Other works looked at embedding strategy prompts in digital text and found it had a positive effect on learners' cognitive load, achievement, attitudes, metacomprehension and calibration accuracy (Reid, Morrison & Bol, 2017). However, another study from the perspective of the influence of the media (digital text vs physical text) on comprehension of text (Ben-Yehudah & Eshet-Alkalai, 2018) found learners improved only in printed condition while answering questions that required inferential processing.

Our study focused on gathering learning traces during an authentic learning task related to critical reading. Such a process-driven narrative regarding learner's behavior in a critical reading task, specifically in a humanities course, is relatively rare and we want to fill in that knowledge gap.

2.3 Learning Evidence Analytics Framework (LEAF)

Learning Evidence Analytics Framework (LEAF) is an overarching technology framework to collect evidence of learning and teaching from the logs generated in a technology-enhanced learning environment (Ogata et al. 2018). In this instantiation of the framework, the instructor coordinated the course on Moodle, an LMS. BookRoll, an e-book reader, was used to upload reading contents like lecture slides, reference articles and reading assignments in PDF format for students to access. Tools like BookRoll can be considered as a learning behavior sensor as it can log student's reading and annotation interactions in a Learning Record Store (LRS) as standard eXperience API (xAPI) statements. Figure 1 presents the technical architecture based on LEAF that is used in our study and the user's reading interface in BookRoll which supports annotation functions such as highlighting with different colors, adding memos and bookmarks in the content. As long as there is an internet connection, students can read their books anytime from a web browser on their personal computer or smartphones. Student's reading activity log from the LRS is then provided to the dashboard database and visualized for both the instructors and students appropriately.

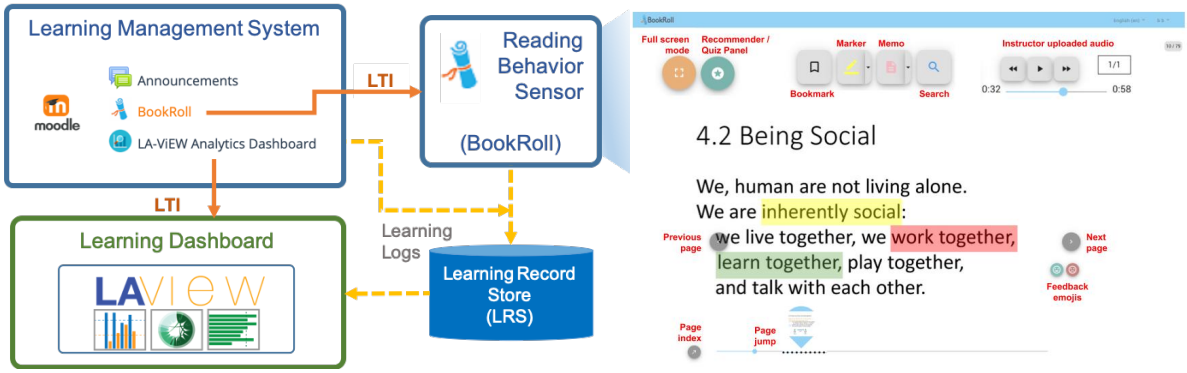


Figure 1. Learning Evidence Analytics Framework and BookRoll reading interface

3. Study Context and Method

As an initiative of a collaborative research project, access to the LEAF platform was given to the instructor and her students at one of the private universities in India. An overall phenomenographic research approach was chosen for the study (Marton 1981, Jan Larsson & Inger Holmström, 2007). It guided the research questions to focus on a single activity undertaken by the students enrolled in the course. The team of researchers including the course instructor then interpreted the different approaches that emerged from the learning logs.

3.1 Context

3.1.1 Course and its Objective

This particular study was conducted in an undergraduate elective course, Critical Analysis of Literature and Cinema (CALC) offered by the Humanities and Social Sciences Department. The objectives of the CALC course are three-fold: 1. to inculcate in students a critical insight required to interpret a work of literature and cinema, 2. to enable the students to perceive the subtle nuances of such works and to develop critical judgment, and 3. to introduce different forms, terminologies and trends prevalent in such artistic ventures to enable them to place a work of art in the proper context. The class was scheduled for 3 hours each week, split across three sessions. Students met for a total of fifteen weeks. In addition to these classroom interactions, students were given take-home readings and film viewings. The semester that just concluded had to undergo a sudden change of plan due to the pandemic and the early lockdown. It was the 9th week into the semester that the instructor had to shift the regular classes to online mode.

3.1.2 Participants

Students enrolled in the course (n=50, 17 males, 23 females) were pursuing their undergraduate program in engineering and sciences in the university. Their ages ranged from 19 to 23 years and the class included students in their second, third or fourth year of study in the university. At the time of the research, they had been introduced to approximately 1 to 3 humanities courses as electives. All the students were registered on Moodle for the following activity.

3.1.3 Critical reading activity: Instructions and example

One of the modules in the course related to critical reading and analysis of a play was orchestrated on the LEAF platform. The instructor chose an Indian play titled Hayavadana (Karnad, 1972), originally written in Kannada and then translated into English by the playwright himself. The content was uploaded on BookRoll and the students were given the task of going through the first act of the play to identify and highlight the following 1. cultural references (red highlight) and 2. performative elements (yellow highlight) in the text designated. The activity was designed around these two factors as the play is deeply steeped in the cultural milieu of traditional Indian theatre. Also, these two tasks were significant for a critical understanding of the play, however it was not a graded activity in the course.

Instructions for the task given to the students were posted on the LMS followed by announcing them to do it during the online synchronous class. There was no intervention from the instructor's side during the reading and annotation activity. An example of the cultural reference and the performative element is shown below. We have selected 2 of the pages which the students have spent most of the time (see section 4.1)

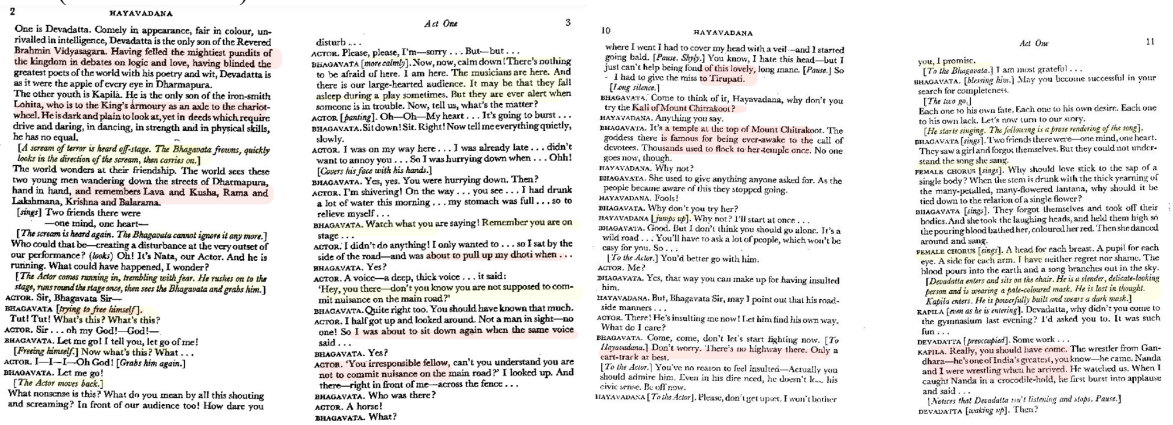


Figure 2. Cultural references and performative elements in page 8 and page 12 of content.

3.2 Data Collection and Analysis

The data extracted for this study included the reading logs from 13 April 2020 to 1 May 2020 in BookRoll. Of the total 50 students enrolled in this course, 22 accessed BookRoll for the reading activity. 2587 logs were captured when the students were reading the play. For this study, we considered the 1575 action logs of opening the play, navigating through its pages and annotating its content. The highlighting event is considered towards fulfilling the given critical reading task.

To answer RQ1, data was collected from the learning analytics dashboard regarding the students access count, their annotations and the time spent on the specific page content. Using the data export option in the dashboard the interaction data for each student was retrieved for further analysis. We consider the following interactions OPEN, ADD MARKER, ADD MEMO, NEXT and PREV from the LAViEW database.

To answer RQ2, we defined four basic profiles of the readers based on their interaction log counts and the interaction duration in the BookRoll system. They are Effortful, Strategic, Wanderers and Check-outs (see Table 1 for definition). The count and duration are considered as a spectrum and for the pilot study we categorized the members based on the actual dataset. Then data is then processed for one member of each profile to illustrate the characteristics of that profile in terms of time spent, navigation pattern and highlighting activity in page 8 and 12 of the uploaded content.

Table 1. Initial profiles of readers based on their interaction log counts and interaction duration.

	Low ---------- Interaction counts ---------- High	
High : Interaction Duration : Low	Strategic Readers who focus on attempting the task and hence activity is concentrated on specific pages related to the task.	Effortful Readers browse through the content and may revisit and go back and forth multiple times while attempting the task.
	Check-out Readers who just opened the content and then left.	Wanderer Readers who just navigated the content without any particular focus on the task.

4. Results and Interpretations

4.1 Information Available in the Dashboard: Overview Statistics and Time Spent on a Page

Figure 3 shows the overview of the content interaction information as seen in LAViEW, the learning analytics dashboard. The first column of information has the total learners who accessed the material and the total number of pages in the content. When one of the students is selected, it shows the average value of the student on the top and the class average on the bottom in the engagement section and the reading activity section. Here student #2548 is selected as an example case. It shows that the student kept the content open for 108.2 minutes when the class average recorded was 35.5 minutes and completion of the material as measured by pages browsed in 83% compared to the class average of 41.4%. The student had a total of 326 events with 47.2% of them more than 3 seconds duration (considered as a long event). The count of the reading activities such as maker and memo annotations are also given in the overview widget for both the teacher and the students.

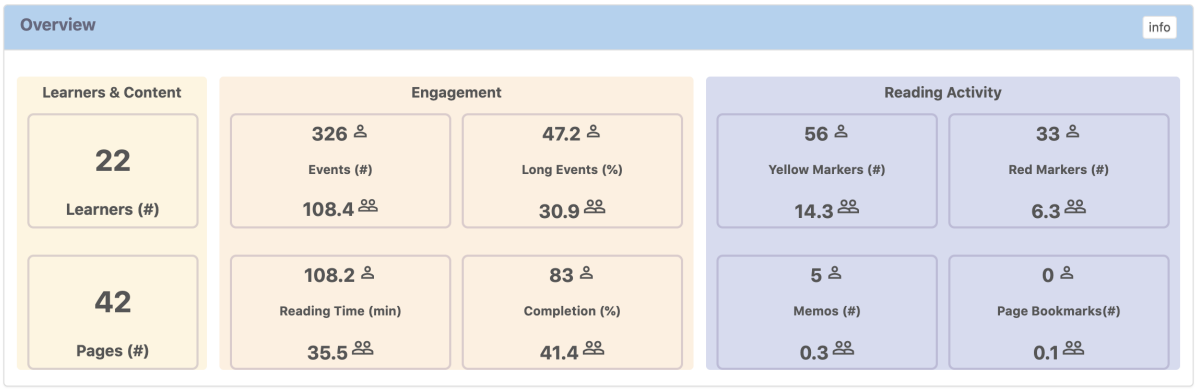


Figure 3. Overview information from LAViEW dashboard

The aggregated average page-wise viewing time is presented in Figure 4. It is calculated by considering content open as a proxy. The difference in time from landing on a page till the next-page or close interaction is considered as time spent on a particular page. Average page-wise viewing time was 2 minutes considering all the users who viewed the book. Based on this distribution, for this content we analyzed annotation activities only in the pages with the top two average times spent, page 8 (4.3 minutes) and page 12 (4 minutes).

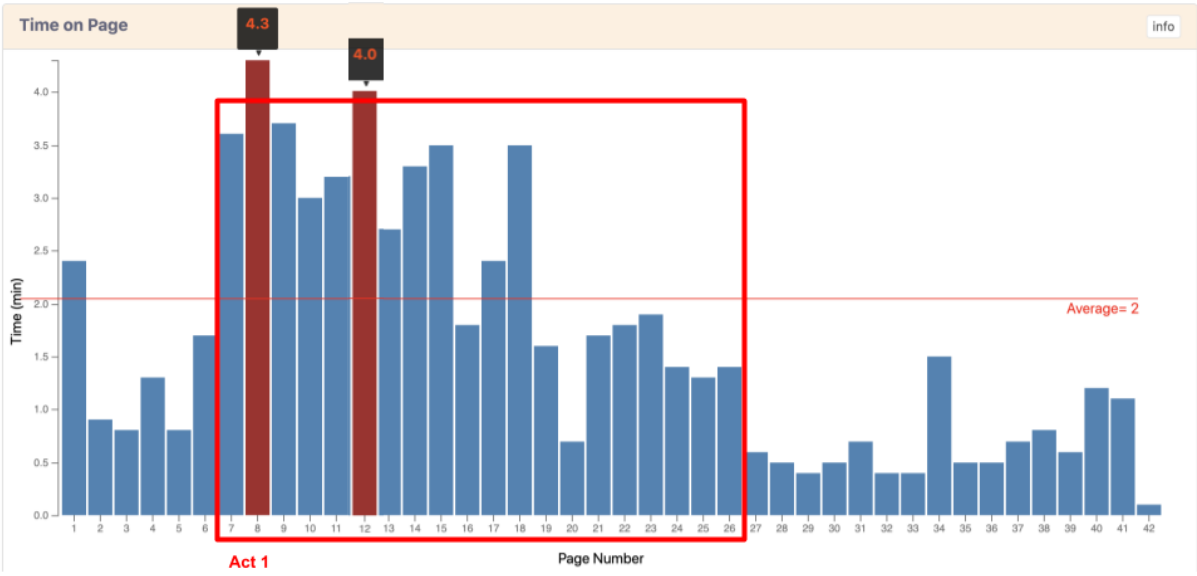


Figure 4. Average page-viewing time across all viewers who read the content.

4.2 Computed Learner-wise details

The distribution of the number of interactions and time spent on each interaction aggregated across all their reading sessions for each of the learners are presented in Figure 6. The figure also indicates the members of different reading profiles and presents the average characteristic values of that profile.

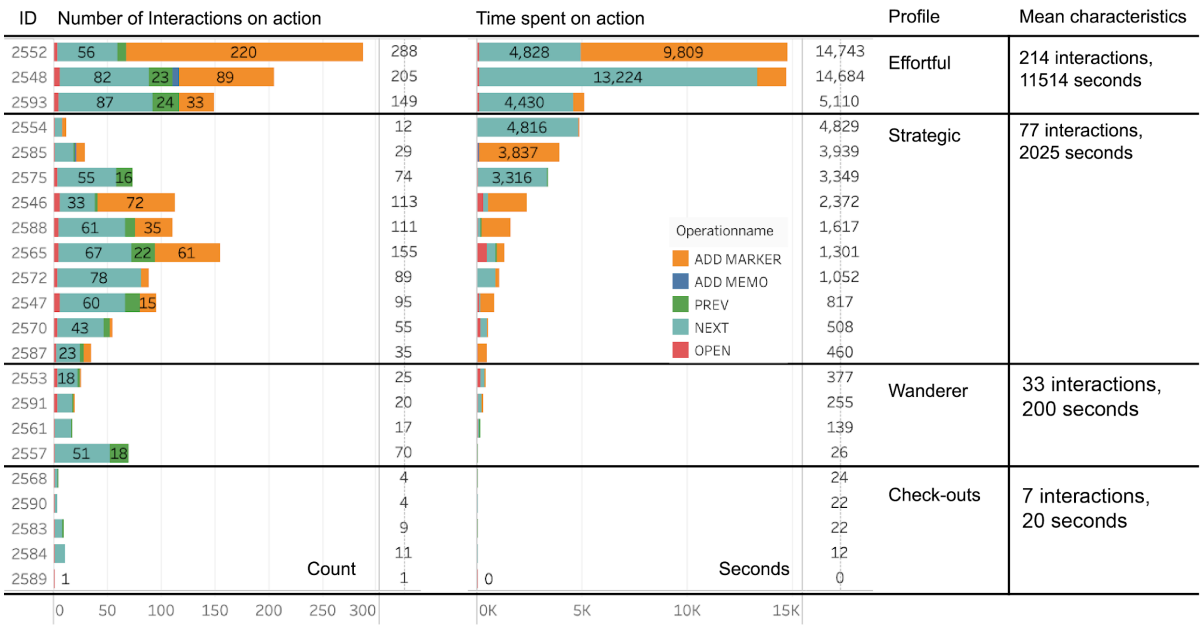


Figure 6. Learner-wise profile based on their total interactions with the content and time spent.

4.3 Characteristics of the Profiles of Critical Reading Activity

Next to answer RQ2, we present the details of candidate members of each profile.

4.3.1 Effortful Reader

Learner 2548 is selected to illustrate an Effortful Reader. The average page viewing time was 3 minutes (Fig 7a). The navigation pattern is presented in Figure 7b. The blue lines indicate the learner did NEXT on a specific page, and the red indicates PREV. The y-axis has the accumulated count of those transitions. Highlighted portions on page 8 and 12 by the learner are shown in Figure 7c and 7d.

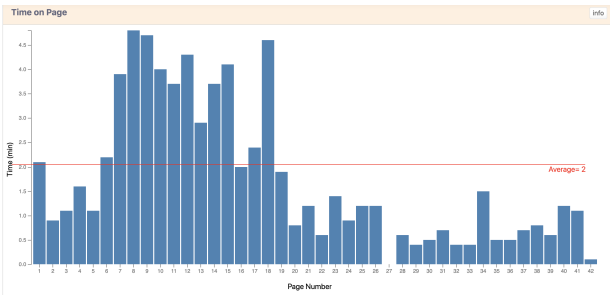
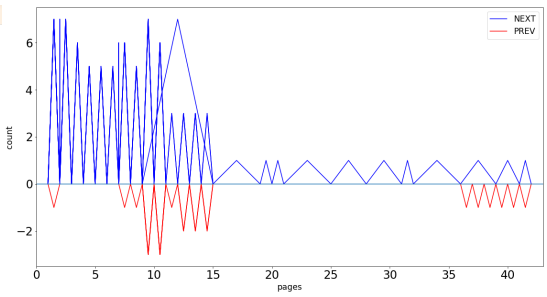
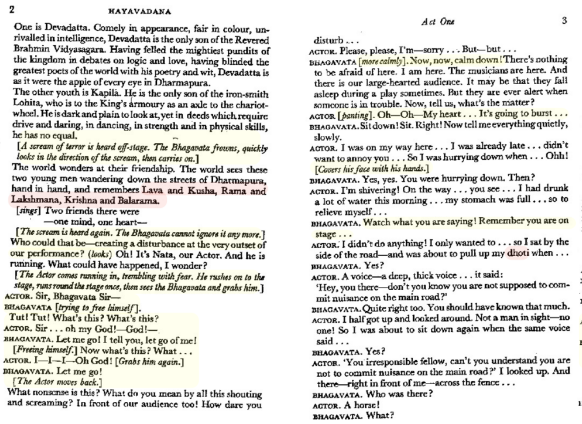


Figure 7a. Page-wise viewing duration



7b. Navigation pattern


2 NAYAVADANA

One is Devadatta. Comely in appearance, fair in colour, unrivalled in intelligence, Devadatta is the only son of the Revered Brahmin Vidyasagara. Having felled the mightiest pundits of the kingdom in debates on logic and love, having blinded the greatest poets of the world with his poetry and wit, Devadatta is as it were the apple of every eye in Dharmapura.

The other youth is Kapila. He is the only son of the iron-smith Lohita, who is to the King's armoury as an axle to the chariot-wheel. He is dark and plain to look at, yet in deeds which require drive and daring, in dancing, in strength and in physical skills, he has no equal.

[A scream of terror is heard off-stage. The Bhagavata freezes, quickly looks in the direction of the scream, then carries on.]

The world wonders at their friendship. The world sees these two young men wandering down the streets of Dharmapura, hand in hand, and remembers Lava and Kusha, Rama and Lakshmana, Krishna and Balarama.

[sings] Two friends there were
—one mind, one heart—

[The scream is heard again. The Bhagavata cannot ignore it any more.]

Who could that be—creating a disturbance at the very outset of our performance? *(looks)* Oh! It's Nata, our Actor. And he is running. What could have happened, I wonder?

[The Actor comes running in, trembling with fear. He rushes on to the stage, runs round the stage once, then sees the Bhagavata and grabs him.]

ACTOR. Sir, Bhagavata Sir—

BHAGAVATA *[trying to free himself].*

Tut! Tut! What's this? What's this?

ACTOR. Sir . . . oh my God!—God!—

BHAGAVATA. Let me go! I tell you, let go of me!

[Freeing himself.] Now what's this? What . . .

ACTOR. I—I—I—Oh God! *[Grabs him again.]*

BHAGAVATA. Let me go!

[The Actor moves back.]

What nonsense is this? What do you mean by all this shouting and screaming? In front of our audience too! How dare you

Act One 3

disturb . . .

ACTOR. Please, please, I'm—sorry . . . But—but . . .

BHAGAVATA *[more calmly].* Now, now, calm down! There's nothing to be afraid of here. I am here. The musicians are here. And there is our large-hearted audience. It may be that they fall asleep during a play sometimes. But they are ever alert when someone is in trouble. Now, tell us, what's the matter?

ACTOR. *[panting].* Oh—Oh—My heart . . . It's going to burst . . .

BHAGAVATA. Sit down! Sit. Right! Now tell me everything quietly, slowly.

ACTOR. I was on my way here . . . I was already late . . . didn't want to annoy you . . . So I was hurrying down when . . . Ohh! *[Covers his face with his hands.]*

BHAGAVATA. Yes, yes. You were hurrying down. Then?

ACTOR. I'm shivering! On the way . . . you see . . . I had drunk a lot of water this morning . . . my stomach was full . . . so to relieve myself . . .

BHAGAVATA. Watch what you are saying! Remember you are on stage . . .

ACTOR. I didn't do anything! I only wanted to . . . so I sat by the side of the road—and was about to pull up my dhoti when . . .

BHAGAVATA. Yes?

ACTOR. A voice—a deep, thick voice . . . it said:

'Hey, you there—don't you know you are not supposed to commit nuisance on the main road?'

BHAGAVATA. Quite right too. You should have known that much.

ACTOR. I half got up and looked around. Not a man in sight—no one! So I was about to sit down again when the same voice said . . .

BHAGAVATA. Yes?

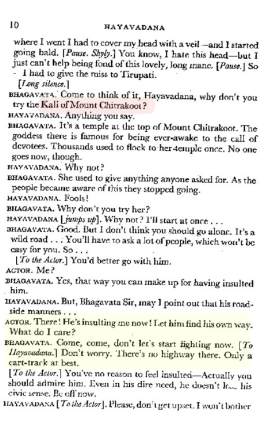
ACTOR. 'You irresponsible fellow, can't you understand you are not to commit nuisance on the main road?' I looked up. And there—right in front of me—across the fence . . .

BHAGAVATA. Who was there?

ACTOR. A horse!

BHAGAVATA. What?

7c. Highlight on pp.8


10 NAYAVADANA

where I went I had to cover my head with a veil—and I started going bald. *[Pause. Shyly.]* You know, I hate this head—but I just can't help being fond of this lovely, long mane. *[Pause.]* So . . . I had to give the miss to Tirupati.

[Long silence.]

BHAGAVATA. Come to think of it, Hayavadana, why don't you try the Kali of Mount Chitrakoot?

HAYAVADANA. Anything you say.

BHAGAVATA. It's a temple at the top of Mount Chitrakoot. The goddess there is famous for being ever-awake to the call of devotees. Thousands used to flock to her temple once. No one goes now, though.

HAYAVADANA. Why not?

BHAGAVATA. She used to give anything anyone asked for. As the people became aware of this they stopped going.

HAYAVADANA. Fools!

BHAGAVATA. Why don't you try her?

HAYAVADANA *[jumps up].* Why not? I'll start at once . . .

BHAGAVATA. Good. But I don't think you should go alone. It's a wild road . . . You'll have to ask a lot of people, which won't be easy for you. So . . .

[To the Actor.] You'd better go with him.

ACTOR. Me?

BHAGAVATA. Yes, that way you can make up for having insulted him.

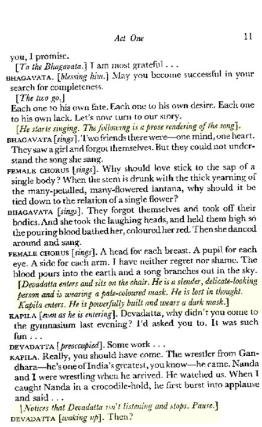
HAYAVADANA. But, Bhagavata Sir, may I point out that his roadside manners . . .

ACTOR. There! He's insulting me now! Let him find his own way. What do I care?

BHAGAVATA. Come, come, don't let's start fighting now. *[To Hayavadana.]* Don't worry. There's no highway there. Only a cart-track at best.

[To the Actor.] You've no reason to feel insulted—Actually you should admire him. Even in his dire need, he doesn't le... his civic sense. Be off now.

HAYAVADANA *[To the Actor].* Please, don't get upset. I won't bother


Act One 11

you, I promise.

[To the Bhagavata.] I am most grateful . . .

BHAGAVATA. *[Blessing him.]* May you become successful in your search for completeness.

[To two ps.]

Each one to his own fate. Each one to his own desire. Each one to his own lack. Let's now turn to our story.

[He starts singing. The following is a prose rendering of the song].

BHAGAVATA *[sings].* Two friends there were—one mind, one heart. They saw a girl and forgot themselves. But they could not understand the song she sang.

FEMALE CHORUS *[sings].* Why should love stick to the sap of a single body? When the stem is drunk with the thick yearning of the many-petalled, many-flowered lantana, why should it be tied down to the relation of a single flower?

BHAGAVATA *[sings].* They forgot themselves and took off their bodies. And she took the laughing heads, and held them high so the pouring blood bathed her, coloured her red. Then she danced around and sang.

FEMALE CHORUS *[sings].* A head for each breast. A pupil for each eye. A side for each arm. I have neither regret nor shame. The blood pours into the earth and a song branches out in the sky.

[Devadatta enters and sits on the chair. He is a slender, delicate-looking person and is wearing a pale-coloured mask. He is lost in thought. Kapila enters. He is powerfully built and wears a dark mask.]

KAPILA *[seen as he is entering].* Devadatta, why didn't you come to the gymnasium last evening? I'd asked you to. It was such fun . . .

DEVADATTA *[preoccupied].* Some work . . .

KAPILA. Really, you should have come. The wrestler from Gandhara—he's one of India's greatest, you know—he came. Nanda and I were wrestling when he arrived. He watched us. When I caught Nanda in a crocodile-hold, he first burst into applause and said . . .

[Notices that Devadatta isn't listening and stops. Pause.]

DEVADATTA *[awaking up].* Then?

7d. Highlight on pp.12

4.3.2 Strategic Reader

Learner 2546 is selected to illustrate a Strategic learner. The strategic learner focused on the area of the task (Fig 8b) and spent more time (average 4 mins) across the pages (Fig 8a). The specific highlighted portions on page 8 and 12 are shown in Figure 8c and 8d.

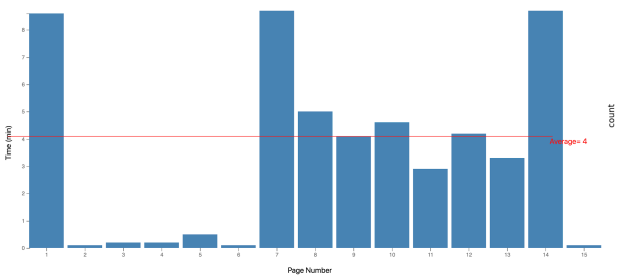
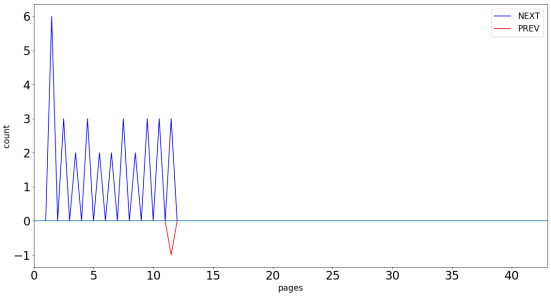


Figure 8a. Page-wise viewing duration



8b. Navigation pattern

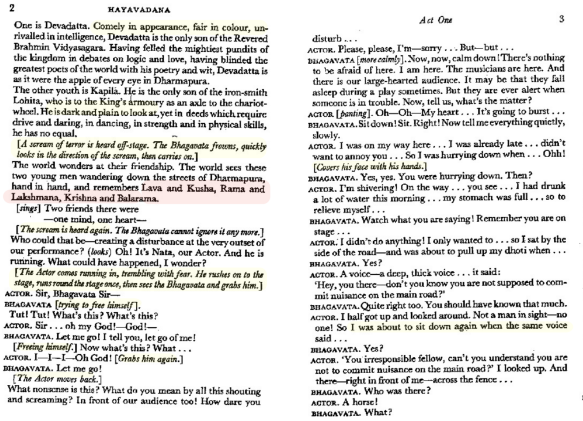
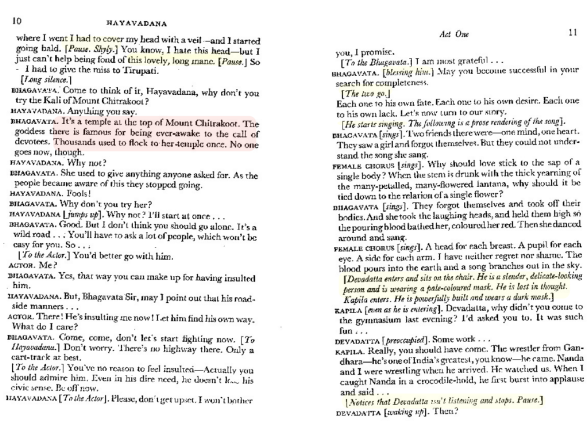


Figure 8c. Highlight on pp.8



8d. Highlight on pp.12

4.3.3 Wanderer and Check-out

Learner 2557 is designated as a Wanderer reader who navigated through the content (Fig 9b) and spent time (average 4 mins) but did not attend to the task. The navigation pattern is presented in Figure 9b.

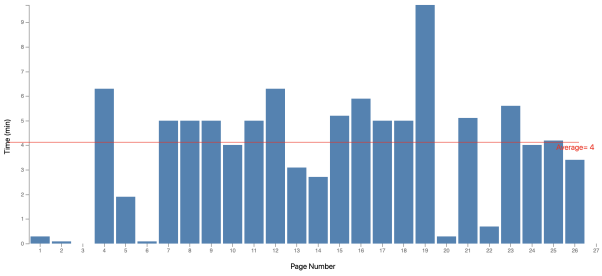
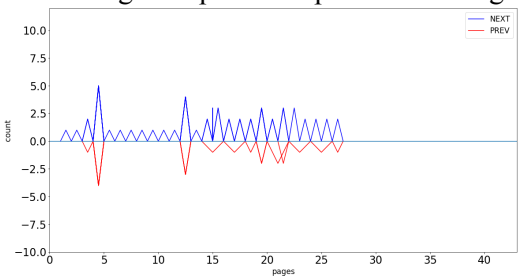


Figure 9a. Page-wise viewing duration



9b. Navigation pattern

Learner 2568 is designated as a Check-out, who just opened the content once and closed the content without even browsing through any page. So, the annotation task was not attempted by the learner in this category.

5. Discussions and Conclusions

5.1.1 Findings and contributions

This study investigated the reading behaviors of learners during critical reading tasks executed on an online e-book reader. This learning logs of interactions in the e-book system and the processed data from the learning analytics dashboard were used to define and describe four different reader's profiles: Effortful, Strategic, Wanderer and Check-outs. While Effortful and Strategic readers attempted to complete the critical reading based highlighting task, the Wanderer and Checkouts didn't attempt it at all. Visualization of the navigation patterns of learners in an e-book context was presented in section 4. It is used to illustrate the characteristics of different profiles. This is also the first attempt to discuss the quantitative account of reading the specific play, Hayavadana.

5.1.2 Critical analysis of Hayavadana: reflections from data

The play Hayavadana is firmly rooted in the Indian tradition and Hindu mythology and yet uses certain subversive tactics to question some of these deep-seated traditions and beliefs. At the performative level, it draws from Yakshagana, a traditional theatrical form practised in the coastal belt of Karnataka, a state in southern India. It also uses a narrator, a chorus and a self-reflexive plot within plot strategy thereby bringing in much talked about alienation effect. Before any critical analysis of the play can commence, students are nudged to engage in a critical reading task- which typically is done before the

classroom discussions. In this study, the activity was done fully using an online environment. The log data provides reading and annotation behavior of a group of learners interacting with the content of the play for the first time. Even though the readers were uninitiated about the conventions of Yakshagana, from the highlights drawn during their reading, it is evident that they did identify simple directions for performance. Tagging such simple directorial notes as performative elements can be attributed to their unfamiliarity with the more nuanced elements taken from the Yakshagana style. Further, the navigation graph data is in congruence with the above reasoning. It shows that Effortful and Strategic readers are particularly engaged in these parts of the text. The data also suggests these readers were clearer and more accurate in the tagging of cultural references as compared to performative elements. Such data-points give a clear indication to the instructor as to where the focus of discussions should be when she goes to the class - whether face to face or online.

5.1.3 Developing profiles of reflective reading and implications for technology design

In earlier works, Binder and Lee (2012) proposed four types of adult readers: Unskilled Readers, Resilient Readers, Good Decoders/Poor Comprehenders and Skilled Reader. Later, Putro & Lee (2018) conducted a latent profile analysis of readers across different modes (printed, online, and social media) and for different purposes (academic and recreational) of reading. They classified low-interest readers, traditional readers, moderate readers and high-interest readers. Still, specifically for critical reading, previous literature lacks any reader's profile. We attempted to approach and fill that gap using learning logs and computing broader navigation patterns of different readers.

Reading strategies and comprehension strategies are considered as cognitive action and remedial action respectively and both assists the learners in achieving reading success (Yang, 2006). A technology framework like LEAF is capable of supporting these aspects by collecting learning logs from the e-reader and using learning dashboards to visualize the traces. Recent work (Gibson et al. 2017) focused on data-driven technology-supported feedback for reflective writing. However, for reflective reading activities, such data-informed digital services are still lacking. This study conceptualized using the interaction count and time as indicators of different profiles of readers. Such indicators are often included in LA dashboards (Tan et al. 2016) and can assist the teachers to directly check the visualized data and decide the status of reflective reading behavior of the learner.

At another level, technical support can also be developed to automatically evaluate the highlighting actions of learners and to give them feedback. During the data analysis process, the instructor highlighted the portions of the text for reference. Presenting the instructor's highlighted part to the learners in the learning dashboard can also assist their learners.

5.1.4 Limitations and future work

This was a pilot attempt to understand and share some of the observed reading patterns and discuss possible ways the learner interacted with the task at hand. Some of the collected data remains difficult to interpret, for instance, the Wanderers, who spent time within the content without attempting the task (indicated by annotation action) it is not possible to distinguish whether they are coping up with comprehending the text before engaging in the critical analysis or just being off task in the system. While consolidating the action logs of 22 learners (44% of the registered participants) generated our dataset, it is still from a smaller sample space to fully comment on critical reading behaviors. This might be primarily due to the fact that the activity was ungraded. Further, in this analysis, we did not consider any explicit learner output apart from the highlights as the artefacts. A model without actual learners' output and only having clickstream interactions has its own limitations regarding validity of the profiles generated. Hence given our analysis, we claim that the profiles are only of the readers based on the engagement attributes (time and clicks), and cannot distinguish learners yet. As a future work there remains further analysis of the data from the pilot study itself. We aim to investigate the quality of the highlighted text by the learner with respect to the instructor's annotation and further compute inferential statistics for the difference of the profiles identified. These would lead to developing learner models specific to critical reading activities.

Acknowledgements

This research was supported by JSPS KAKENHI 16H06304, 18H05746 (F.Y.2018), 19K20942 (F.Y.2019), 20K20131, 20H01722, SPIRITS 2020 of Kyoto University and Teaching Learning Centre (TLC), BITS Pilani K. K. Birla Goa Campus (2019).

References

Ben-Yehudah, G., & Eshet-Alkalai, Y. (2018). The contribution of text-highlighting to comprehension: A comparison of print and digital reading. Journal of Educational Multimedia and Hypermedia, 27(2), 153-178.

Binder, K. S., & Lee, C. (2012). Reader profiles for adults with low literacy skills: A quest to find resilient readers. Journal of research and practice for adult literacy, secondary, and basic education, 1(2), 78.

Chen, M. R. A., Ogata, H., Hwang, G. J., Lin, Y. H. & Akçapınar, G. (2019, Sep). Effects of incorporating a topic-scanning guiding mechanism in e-books on EFL reading comprehension, learning perceptions, and reading behaviors. The Second International Cognitive Cities Conference (IC3 2019), Kyoto, Japan.

Douglas, N. L. (2000). Enemies of critical thinking: Lessons from social psychology research. Reading Psychology, 21(2), 129-144.

Ennis, R. H. (1993). 'Critical thinking assessment', Theory into Practice, 32, 179 – 86.

Gibson, A., Aitken, A., Sándor, Á., Buckingham Shum, S., Tsingos-Lucas, C., & Knight, S. (2017, March). Reflective writing analytics for actionable feedback. In Proceedings of the seventh international learning analytics & knowledge conference (pp. 153-162).

Jan Larsson & Inger Holmström (2007) Phenomenographic or phenomenological analysis: does it matter? Examples from a study on anaesthesiologists' work, International Journal of Qualitative Studies on Health and Well-being, 2:1, 55-64, DOI:10.1080/17482620601068105

Jonathan, C., Tan, J. P. L., Koh, E., Caleon, I. S., & Tay, S. H. (2017). Enhancing students' critical reading fluency, engagement and self-efficacy using self-referenced learning analytics dashboard visualizations.

Karnad, G. (1972) Havayadana, in The Oxford Dictionary of Plays. online reference https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095925443

Holm, P., Jarrick, A., & Scott, D. (2015). Humanities world report 2015. Springer Nature.

Marton, F. (1981). Phenomenography—describing conceptions of the world around us. Instructional science, 10(2), 177-200.

Ogata H., Yin C., Oi M., Okubo F., Shimada A., Kojima K and Yamada M.(2015) E-Book-based Learning Analytics in University Education, Proc. Of ICCE 2015, pp. 401-406.

Putro, N. H. P. S., & Lee, J. (2018). Profiles of Readers in a Digital Age. Reading Psychology, 39(6), 585-601.

Pithers R.T. & Soden R. (2000) Critical thinking in education: a review, Educational Research, 42:3, 237-249, DOI: 10.1080/001318800440579

Reid, A. J., Morrison, G. R., & Bol, L. (2017). Knowing what you know: improving metacomprehension and calibration accuracy in digital text. Educational Technology Research and Development, 65(1), 29-45.

Sergis, S., Sampson, D. G., Rodríguez-Triana, M. J., Gillet, D., Pelliccione, L., & de Jong, T. (2019). Using educational data from teaching and learning to inform teachers' reflective educational design in inquiry-based STEM education. Computers in human behavior, 92, 724-738.

Tan, J. P. L., Yang, S., Koh, E., & Jonathan, C. (2016, April). Fostering 21st century literacies through a collaborative critical reading and learning analytics environment: user-perceived benefits and problematics. In Proceedings of the sixth international conference on learning analytics & knowledge (pp. 430-434).

Yang, Y. F. (2006). Reading strategies or comprehension monitoring strategies?. Reading Psychology, 27(4), 313-343.