

The Impacts of Influential Factors on Flow in Digital Reading

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ABSTRACT

In this paper, we investigate the impacts of the following four influential factors on flow in digital reading: contents, platforms, motivations, and places. The contents factor was subdivided into “news articles” and “journal papers”; platforms is comprised of “mobile phones,” “tablets,” and “laptops”; motivations consists of “pleasure” and “assignments”; and “home,” “on the go,” and “out of home” are the subdivisions of the places factor. We conducted a questionnaire survey with the study’s participants and the following results are shown: 1) The flow during the reading of news articles is influenced by motivations, whereas the flow during the reading of journal papers is influenced by platforms. 2) Regarding mobile phones, motivations significantly affected the flow, whereas content types significantly affected the flow for tablets; also, laptops provided the best flow and articles can be read on the platform regardless of motivations. 3) Reading for pleasure rather than for assignments positively influenced the flow for all of the platforms. 4) With respect to news articles, the places providing flow are different across platforms. However, for journal papers, the places out of home provided good flow. For tablets, the places for flow significantly depended on the content type, which is not the case for laptops.

Key words: Digital Reading, Flow, Influential Factor, Platforms, Contents, Motivation, Places.

1. INTRODUCTION

Recently, e-book reading is on the fast rise, which brings about the development of e-book devices and apps. According to Pew Internet, more than half of American people own tablets or e-readers, and the number of e-book readers increases to 28% in January 2014, up from 23% in 2013 [1]. Durant & Horava [2] said, “In the age of Google, many users do not expect to come to the library at all.”. However, there is a negative view on reading from e-book devices such that reading in the digital environment hampers people’s deep reading and thinking and thus weakens their ability of understanding and memorizing objects [3]. It is then crucial in digital reading how to help readers to achieve deep reading and thinking.

It is well known that achievement through reading largely depends on readers’ flow. Thus, research on flow in reading has been conducted extensively in the cognitive science and pedagogy literature. McKenna & Kear [4] conducted research on successful reading and argued that the motivation and

engagement in reading have significant impacts on reading education. It is also found that flow in reading shortens learning hours, facilitates active participation into learning activities, and positively affects academic achievements [5]-[7]. In line with this, to achieve flow in reading, many apps in digital environment have been developed in various platforms.

In digital platforms and applications, the physical experience on reading is important. For example, Mangen [8] argued that the factors affecting flow in reading are not only internal ones, such as reading attitude and motivation, but also physical experiences gained from books. Durant and Horava [2] also supported the importance of physical interaction in digital reading. Worthy et al. [9] emphasized the importance of physical environment to promote situational interest in voluntary activities such as reading. Thus, in the digital environment, the physical difference of inputs and outputs in various platforms and apps may affect flow in reading different from those in traditional environment.

In digital environment, texts are easily accessible in any time and at any place such that readers can choose whatever contents they want to read. Nell [10] found that “readers are more aroused in their self-selected book rather than in the assigned text.” Thus, it is important to understand what factors may influence flow in reading in digital environment and how these factors affect flow in reading. Kang and

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Eune [11] found that readers' preferences on contents depend on the platform of reading in digital environment. However, they did not consider other factors like the place of the reading and reader's motivation, which may change the relation established in the work of [11].

In this study, we aim to understand the relationship among several factors that may influence flow in reading in digital environment. In particular, we consider platform, place, contents, and motivation as factors that influence flow in reading and investigate which combination of these factors may enable to readers to achieve flow in reading easily than others.

We first conduct literature review to define flow of digital reading and identify important influential factors on flow in digital reading. Then, to analyze the effect of the factors through a questionnaire survey, we determine the elements that belong to each factor. Throughout the questionnaire survey, we analyze the impact of influential factors and their combinations of elements on flow in digital reading. We believe that the result of this study would be instrumental in designing the reading apps in digital environment by helping the readers engage in flow under cross platforms.

2. BACKGROUND

2.1 Definition of Flow in Digital Reading

Csikszentmihalyi [12] defined flow as "the optimal mental state of operation in which a person is fully immersed in the process of activity and thus forgets the flow of time, space, and even the thought of him/herself". He claimed that such flow experiences occur in various fields. Research on flow shows that almost all of the study subjects experience flow in reading activity among many different activities [13]. Based on the work by Csikszentmihalyi [14], Webster & Trevino [15] defined flow in the digital environment as users' perception that the interaction with media is interesting and exploratory. Novak & Hoffman [6] described flow in the digital environment as the mental state occurring in the course of navigating in network. They claimed that when users concentrate on interaction and when their irrelevant thoughts and perception disappear, flow appears.

As a study on flow in digital reading, Douglas & Hargadon [16] conducted research on the flow in hypertext reading. They argued that flow in hypertext reading occurs when a reader is performing immersion and engagement supremely well and effortlessly. According to them, the immersion represents the state in which a reader is fully absorbed in familiar narrative schema. Also, the engagement comes from a reader's ability of recognizing the conflict between the existing schema and a reading story and ability of combining or overturning one of them. Mangen [8] divided immersion in hypertext fiction reading into two types. One is phenomenological immersion that comes from the fictional world created by his/her mental act of imagination. The other is technological immersion that comes from the virtual reality created and kept by the technological features in a screen like a game and by physical devices. Kang and Eune [17] claimed that flow of digital reading consists of the cognitive immersion appearing in traditional reading, and the affective, cognitive and participatory immersions through multi-modality appearing in the digital environment.

2.2 Influential Factors of Flow in Digital Reading

Durant and Horava [2] insist that digital reading is not the same as reading from the printed page. They argue "it fosters a different set of cognitive skills and indeed a qualitatively different way of thinking." Therefore, in the digital environment, the factors affecting flow in reading can be different from the ones in the traditional environment. However, there had been few attempts to classify the factors to affect flow of digital reading.

To study the factors that affect reader's flow, Lee [18] classified the influential factors on reading motivation and engagement into four categories: textual features factor, a reader's internal factor, the factor of teachers and class environment, and the factor of family and family environment. Since this classification is conducted from the perspective of education, we adapt this to apply for reader's flow in reading into three categories: textual, internal, and environmental factors.

The textual factor represents the interest based on texts. It has been touched by many works such as [19], [20]. Kirsch and Guthrie [21] insisted that reading for specific information would not produce a flow experience. Nell [10] and McQuillan & Conde [22] divided contents into fiction and non-fiction and showed that fiction is significantly more likely to produce flow than non-fiction texts. However, in digital reading, readers popularly read newspapers or magazines to obtain information [23]. We thus focus on non-fiction contents in the textual factor in our study.

As the types of non-fiction contents, we choose information and knowledge from the DIKW Pyramid, which classifies contents into data, information, knowledge, and wisdom [24]. We look into the differences in flow between information and knowledge. We set one element of contents factor as a news article that represents information and the other element as a journal paper that represents knowledge.

The reader's internal factor represents a reader's belief in its personal reading ability, which means self-efficacy. According to the theory of Bandura, the self-efficacy is defined by a learner's belief that he/she has the ability to complete or learn specific activity to his/her goal level [25]. Sperling & Head [26] showed that positive reading attitude and high motivation are the main factors leading to successful reading. Chung [27] pointed out that among these reader's internal factors, reading motivation plays an important role in triggering reading activity, which we set as the internal factor in this study.

Reading motivation is made up of self-efficacy, goals, and social aspects [29]. McQuillan & Conde [22] studied the impact of goals on flow by conducting a questionnaire survey. They compare the case of reading articles for assignments with the case of reading for pleasure. As the result of the survey, most respondents showed flow occurs more easily when reading articles for pleasure than for assignments. From the study, we choose assignment and pleasure as elements of motivation factor and study if good flow in digital reading depends on such elements of reading motivation

Lee [18] pointed out that flow in reading is influenced by the circumstances of a reader, e.g., teachers and class environment. Oldfather & McLaughlin [29] also claimed that the class environment with more students, less individuality, and more formality, and teachers-centered circumstances reduces a learner's motivation and engagement in reading. McQuillan and Au [30] state "the presence of more reading materials in the classroom and in school is associated with

greater reading frequency and achievement, controlling for socioeconomic confounds” [31]-[34].

We learned that environments around readers affect reading performance. In digital reading, portability of devices allows people to read any articles and books in various conditions and places. Therefore, the place (circumstance) where a person is well engaged in reading specific contents on a specific platform is chosen as the place factor. The Multi-Screen World by Google [35] that presented the analysis of the activities taken by multi-screen users reported that the users’ activities are different depending on the places where each platform is mainly used. From the Google’s report, we choose at-home space, out-of-home space, and on-the-go space as elements of place factor. In addition, we subdivided at-home space into living room, rest room, and bed; out-of-home space into office/lab., café, library and park bench; and on-the-go space into bus and subway. Each place includes time to stay, attitude, and mental state about openness of the place. For example, a living room is an open rest space; a bed is a private and comfort space; a bathroom is a private and temporary space; an office is a formal and long-staying space; and a subway is a temporary and open space. Table 1 shows the characteristics of places. With these elements for the place factor, we study how flow of digital reading depends on places along with content types and platforms.

Table 1. Characteristics of places

Place		Time to stay		Attitude		Openness	
		Short	Long	Formal	Informal	Private	Public
At Home	Bathroom	•			•	•	
	Bed	•			•	•	
	Living Room		•		•		•
On the go	Bus/Subway	•			•		•
Out of home	Office/Lab		•	•			•
	Cafe		•		•		•
	Library		•	•			•

Based on the literature review, we choose contents, platforms, motivations, and places as the four main influential factors on flow in digital reading. The combinations of elements for the four factors are then analyzed with the questionnaire survey. Table 2 summarizes the factors and elements used in this study.

Table 1. Influential Factors and Elements

Factors	Elements
Contents	News, Journal papers
Motivation	Pleasure, Assignments
Platforms	Mobile phones, Tablets, Laptops
Place	At home (Rest room, Bed, Living room), On-the-go (Bus/Subway), Out of home (Office/Lab., Cafe, Library, Park bench)

3. SURVEY

3.1. Survey Design

In this chapter, we describe the questionnaire survey used in this study. Throughout this survey, we investigate how the four influential factors—contents, platforms, motivation, and places— would affect flow in digital reading. Because the contents of this survey include journal papers, we choose researchers, e.g. graduate students who write a master’s thesis and those working for teaching or research as the subjects of the survey. We collect total 40 men and women in their 20s to 40s as the study subjects (Table 3). They conduct online survey.

Table 3. Subjects

Age	Male	Female	Total
20s	2	5	7
30s	13	8	21
40s	8	3	11
total	23	16	40

Table 4 summarizes the questionnaire. A total of eight questions except for questions about profile were asked on line. The questions have the type of prioritizing the combinations of the elements by factor in terms of flow in reading. Based on the prioritization in each question, we obtain the ranking of each combination by question and calculate the mean. The smaller the mean is, the better flow in reading the combinations produce. The differences of the means of each ranking are then tested statistically with paired t-test.

Table 4. Questionnaires

Profile	Gender, age, use of i-pad
Impact of platforms, contents, and motivation on flow of reading	<ul style="list-style-type: none"> • In terms of reading news articles, prioritize the combinations of influential factors depending on extent of flow. • In terms of reading journal papers, prioritize the combinations of influential factors depending on extent of flow.
Impact of platforms, contents, and places on flow of reading	Choose the places helping the flow of reading <ul style="list-style-type: none"> • Newspapers in Mobile phone • Newspapers in Tablet • Newspapers in Laptop • Journal paper in mobile phone • Journal paper in Tablet • Journal paper in Laptop

3.2. Survey Results

For contents factor with news and journal papers, we investigate the impact of combinations of motivation and platform factors on flow in reading. For the investigation, six categories by each type of contents are asked as shown in the following, and the questionnaire respondents place them in the order of flow in reading.

- When reading for pleasure in mobile phones
- When reading for pleasure in tablets
- When reading for pleasure in laptops

- When reading for assignments in mobile phones
- When reading for assignments in tablets
- When reading for assignments in laptops

3.2.1 By Content Factor: In this section, we present the result of the questionnaire survey by each elements of the content factor—news article and journal paper. Fig. 1 shows the survey results when news articles are read. We observe that when the news are read for pleasure, the impact of platform factor on flow in reading is not significant, whereas noticeable differences are observed when news articles are read for assignments.

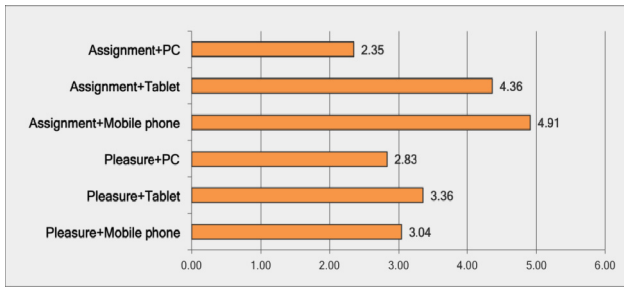


Fig. 1. Influential Factors of Flow in News reading

An independent sample t-test was conducted to compare the differences in preferences. Results of the statistical test are summarized in Table 5. The table shows that there is no statistically significant difference across platforms in news articles reading for pleasure. However, there are statistically significant differences between laptop and tablets / mobile phones in news articles reading for assignments. These results suggest that flow dose not significantly depend on platforms in reading news articles for pleasure. Flow of reading news articles in laptops for assignment is better than in other platforms.

Table 5. t-test results between platforms in motivations of News reading

Motivations	Platforms	p-value
Pleasure	Mobile phone vs Laptop	.636
	Mobile phone vs Tablet	.392
	Tablet vs Laptop	.211
Assignment	Mobile phone vs Laptop	.000*
	Mobile phone vs Tablet	.103
	Tablet vs Laptop	.000*

*p<0.05

We analyze how the two elements of reading motivation factor—pleasure and assignments— affect flow when news is read. As shown in Table 6, in mobile phones, there is a statistically significant difference between the reading motivation factors. When news articles are read, reading motivation significantly influences flow of reading in mobile phones. However in tablets and laptops, there is no statistically significant difference between the reading motivation factors.

Table 6. t-test results between motivations in platforms of News reading

Platform	Motivations	p-value
Mobile phone	Pleasure vs Assignment	.001*
Tablet	Pleasure vs Assignment	.097
Laptop	Pleasure vs Assignment	.259

*p<0.05

Fig. 2 illustrates the differences in flow in reading for each platform when the journal articles are read. The figure shows that flow in reading journal articles for both pleasure and assignments is more likely to occur in the order of laptops (PC), tablets, and mobile phones. Unlike news articles, the difference between motivation factors is not obvious in a platform so that we compare the platform factors based on the motivations.

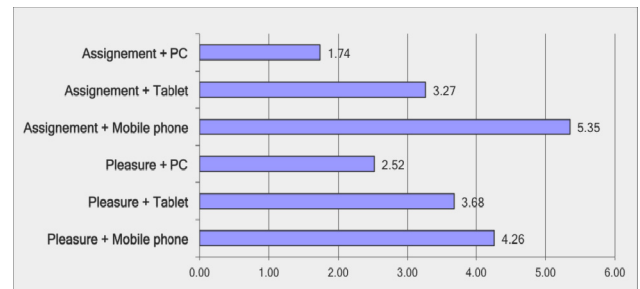


Fig. 2. Influential Factors of Flow in Journal Paper reading

Statistical test results shown in Table 7 confirm that the flow of reading journal paper for assignments is significantly different across platforms. However, difference in flow in reading journal papers for pleasure is not significant between mobile phones and tablets at the significance level of 5%. The flow in reading journal papers for pleasure is better in the order of laptops, tablets, and mobile phones. We can thus conjecture that flow of reading journal papers is largely influenced by platforms.

Table 7. t-test results between platforms in motivations of journal paper reading

Motivations	Platforms	p-value
Pleasure	Mobile phone vs Laptop	.000*
	Mobile phone vs Tablet	.101
	Tablet vs Laptop	.001*
Assignment	Mobile phone vs Laptop	.000*
	Mobile phone vs Tablet	.000*
	Tablet vs Laptop	.000*

*p<0.05

3.2.2 By place Factor: As mentioned earlier, we divide places into at-home space, out-of-home space and on-the-go space elements. Also, we subdivide at-home space into living room, rest room, and bed; out-of-home space into office/lab., cafe, library, and park bench; and on-the-go space into bus and subway. In the questionnaire, survey participants were allowed to make multiple choices when being asked to choose their favorite places for reading

news articles or journal papers in mobile phones, tablets, and laptops.

The result of questionnaire survey, as illustrated in Fig. 3, shows that there are three groups of places, which provide good flow when news articles are read in mobile phones. The places chosen most are bus/subway (67.6%) and bed (55.9%). The next favorites are bathroom at home (38.2%), café (35.3%), and living room (32.4%). The last ones are office/lab.(14.7%), library(8.8%), and park bench (2.9%). We conduct one-way ANOVA on the three groups to see the impact of places on flow in reading and obtain statistical significance at the significance level of 5%. Therefore, places significantly influence flow in reading when news articles are read in mobile phones. When survey participants were asked to choose the places which provide good flow when journal papers are read in mobile phones, bus/subway (58.8%) was chosen most as shown in Figure 3. Although other places- café (29.4%), office/lab. (26.5%), bed (20.6%), living room (17.6%), library (14.7%), bathroom at home (11.8%) were also chosen, there is no significant difference in flow in reading.

This result suggests that the survey participants experience the best flow when reading both news articles and journal papers on the go. Also, we found that they experience good flow when reading news articles at home. However, in the case of their reading of journal papers, they have no other favorite places than bus/subway, because journal papers do not seem to be read well in mobile phones.

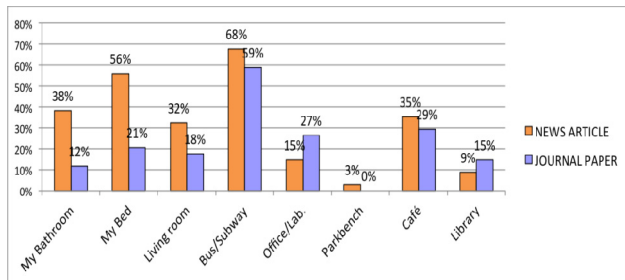


Fig. 3. Places affecting flow depending on content types in Mobile phones

Fig. 4 illustrates the places affecting flow of reading in tablets. When news articles are read in tablets, the most chosen places that provide the best flow are living room (50%) and bed (38%). It indicates that home spaces provide good flow of reading. The second most chosen are café (32%) and office/lab. (29%), which long-staying spaces out of home. Interestingly, the temporary spaces such as bathroom (21%) or bus/subway (21%) provide relatively less flow of reading in tablets than in mobile phones. When journal papers are read in tablets, the most chosen place that provides good flow is office/lab. (59%), and the second ones are café (38%) and library (38%). This implies that formal spaces out of home produce better flow than spaces at home when journal papers are read in tablets. Therefore, in the case of tablets, the places that provide good flow are different across content types.

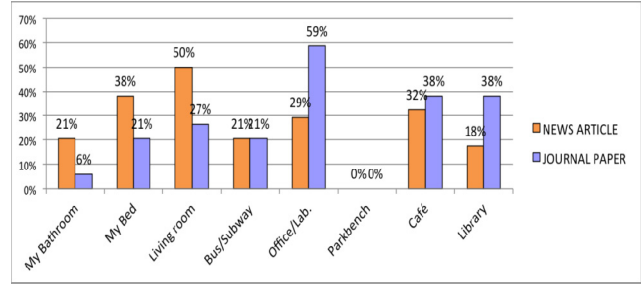


Fig. 4. Places affecting flow depending on content types in Tablets

When news articles are read in laptops, Fig. 5 illustrates the ranking of flow in reading by places. In this case, the places that provide good flow are similar when news articles and journal papers are read. In other words, for both contents, more than 90% (91% for news articles and 94% for journal papers) of respondents indicated that office/lab. provides the best flow, and the second most chosen place is library (41% for news articles, 59% for journal papers), and the third most chosen is café (32% for news articles, 32% for journal papers). However, at-home spaces and temporary spaces are hardly chosen.

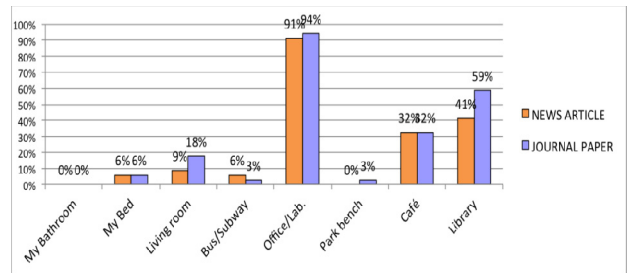


Fig. 5. Places affecting flow depending on content types in Laptop

We observe that when contents are read in tablets, the places that provide good flow are different across content types. However, when contents are read in laptops, the places that provide good flow are not significantly different by content types. Regardless of contents type, readers tend to experience flow of reading more easily when they are in office/Lab or library, which provide a table so that their posture can be comfortably set for reading.

4. DISCUSSION

Fig. 6 and Fig. 7 illustrate the impact of motivation and platforms on flow in reading depending on the content factor. The red zone means good flow in reading, and the yellow zone means less significant difference in flow in reading.

As shown in the red zone on the top image of Fig. 6, flow in reading is good in all platforms when news articles are read for pleasure. However, as shown in the yellow zone of the figure, flow in reading is not significantly different in other two platforms than laptops when news articles are read for assignments. These results mean that when news articles are read, the motivation factor significantly affects flow whereas the platform factor does not so.

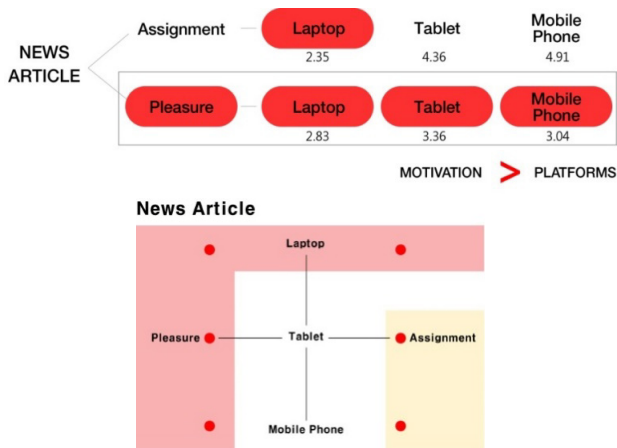


Fig 6. Difference of flow for each motivation-platform in news article reading

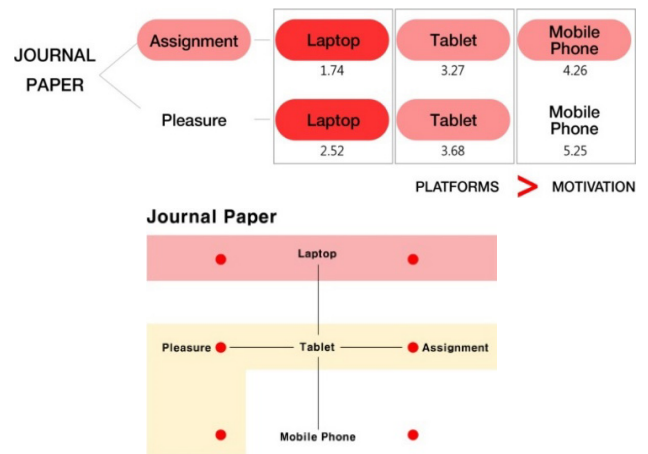


Fig 7. Difference of flow for each motivation-platform in journal paper reading

In the case of journal papers, as illustrated in the top image of Fig. 7, the color changes vertically. It means that the platform factor, rather than the motivation factor, significantly affects flow in reading when journal papers are read. Since journal papers contain professional knowledge, readers of journal papers already tend to have reading motivation. Therefore, in the case of journals, it is observed that the reading motivation factor does not significantly affect flow in reading.

Regardless of the motivation factor, we observe that reading in laptops positively affects flow. Therefore, it can be said that laptops are the best platform accepting articles about information and knowledge in the digital environment. In this study, we only consider digital reading in their native language. In the future, it would be interesting to investigate how the results change if the subjects are reading articles in their second language, for example, in English.



Fig. 8. Difference of flow depending on content types

Fig. 8 illustrates the impact of the place factor on flow in reading. When news articles are read in mobile phones, the most chosen places that provide good flow in reading are bed and bus/subway. The common features of these places are that they are casual and temporarily staying spaces. Bus/subway is a temporarily staying place on the go, and bed is the most comfort and relatively short staying place in the awakening state during a day. The places which provide the least flow are office/lab., and library. They commonly share the feature of long-staying for working or studying. Therefore, we claim that when news articles are read in mobile phones, the short-staying and casual places positively affect flow.

However, we found that spaces at home provide good flow when news articles are read in tablets, whereas spaces out of home provide good flow when journal papers are read in tablets. This implies that when contents are read in tablets, the places positively affecting flow are different. Therefore, depending on places, it would be helpful to provide proper contents for users who carry tablets in and out of home.

We also found that when news articles and journal papers are read in laptops, the places positively affecting flow are not different by the content factor. This suggests that content factor is not closely related to the place factor in terms of flow in reading in laptops. Since laptops platform strongly has business characteristic, office/lab. seems to be chosen most highly. The common features of these three most chosen places (office/lab., library, and café) are that they have tables for laptops that help users take comfort postures. Given that, it can be said that the physical postures taken to use devices in digital reading have an important influence on flow in reading.

According to Oldfather & McLaughlin [29], flow in reading is relatively hard to occur in formal and less private places. We similarly observe that in the cases of two other platforms than the platform of laptops, private and casual places like home provide good flow when news articles, casual contents, are read or when contents are read for pleasure. However, formal places like office and library provide good flow in reading when journal papers that convey knowledge are read or when contents are read for assignments.

We believe that the impact of each influential factor on flow in reading revealed in this study would be instrumental in designing applications on the basis of one factor and in understanding the combinations of the elements of each factor that positively affect flow in reading. For example, when a reading app conveys both knowledge and information contents across platforms, the result of this study would be helpful to prioritize contents to be accessed by users based on the places and platforms so that they can find their desired contents quickly. More specifically, for a tablet-based reading app, the function of prioritizing contents based on places would be necessary such as information articles like news articles at home, and knowledge contents at office or library. Also, in the mobile phone platform, prioritizing information articles more than knowledge contents may help users experience flow in reading in general.

5. CONCLUSIONS

In this paper, based on the literature review, we identified four main factors influencing flow such as contents, motivation, platforms and place and subdivided each factor into elements.

We conducted a questionnaire survey to investigate how the combinations of the factors and elements would affect flow in digital reading.

Our analysis of the survey result shows that, just as the research on traditional reading, reading for pleasure in general causes more flow than for assignments in digital devices. In a mobile phone, motivation significantly affects flow, and in a tablet, content types significantly affect flow. A laptop is identified as the best platform for flow in reading news articles regardless of motivation and content type.

In addition, the three platforms made differences in flow in reading depending on the places. In tablets, we found that the places positively affecting flow are different depending on content types. In laptops, the characteristics of the platform rather than the content types, mainly influences flow. In news articles, the places providing flow are different depending on platforms, and in journal papers, the places out of home provide good flow.

In summary, our findings show that it is crucial in designing a reading app to recognize users' circumstances, find their purposes for using the reading app, and appropriately provide contents and functions. We believe that the result of this study would be useful for designing a reading app in cross platforms in consideration of the combinations of the influential factors on flow in reading.

There are some limitations in this research. First, our survey is conducted for a relatively small number of respondents. Also, our findings are only based on the survey. Thus, conducting an extensive experimental test may provide more useful and robust results.

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