



**A study of learners' interactive preference on multimedia  
microlearning**

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## A study of learners' interactive preference on multimedia microlearning

### Abstract

**Purpose:** This study aims to explore how learners prefer to interact with microlearning videos. Microlearning is an emerging topic in work-based learning and the benefits of using video in supporting learning have been widely discussed. However, only very few of previous works were conducted on discussing how learners prefer to interact with microlearning video. This paper aims to fill this knowledge gap.

**Methodology:** A questionnaire was used in this study for data collection purposes. In total, the invitation had been sent to 236 enrolled learners from the 3 targeted modules through emails. 77 participants completed the survey with the response rate 32.6%. Chi-square is used in this study in order to conclude whether the findings from the sample related to hypotheses are statistically significant.

**Findings:** By analysing primary data collected from a UK University, our findings suggest that: i) the perceived usefulness of the control functions and the expression functions of multimedia microlearning videos are generally high, ii) more participants prefer to have more control in their multiple-choice question's arrangement and open-ended question's arrangement, on the other hand, there was no significant difference on the preference of when to attempt assessment.

**Originality:** This is the first time that a study like this had been conducted to review and discuss the interactive preferences between learners and multimedia microlearning. This study could shed some lights on future research in the field of microlearning and work-based learning.

## 1. Introduction

Microlearning is an emerging topic in work-based learning. Microlearning involves short learning time, short-term-focused activities and relatively small learning contents (Hug, 2005; Leong *et al.*, 2020). As per Overton (2011), in the current competitive business environment, on-demand learning and access up-to-date information were preferred by managers. According to Emerson and Berge (2018), microlearning facilitates acquisition of knowledge in the workplace through motivating and engaging staffs to communicate and apply what they have learned. On the other hand, Madden and Govender (2020) further indicates training and development departments of many organisations focus on emerging concept of microlearning to support multitask-orientated, fast-paced and digitally savvy learners. Furthermore, Hesse *et al.*, (2019) suggest that microlearning is effective in improving the feelings of confidence and accuracy in work. This is similar to the viewpoints from Chisholm (2005) and Downes (2005), in which they summarised how renewed and innovative ways of learnings are required for how humans live, work and learn today. In summary, microlearning is a promising approach in talent development, as concluded by Moore (2017).

Video is a type of multimedia and it is effective to deliver microlearning. Yousef *et al.*, (2014) found that use of video-based learning improves both the teaching methods and learning outcomes. Delen *et al.*,(2014) indicated that video-based learning environment is a more effective tool compared with traditional learning environment. Geri (2012) concluded a possible positive relationship between video lectures and senior students' retention. Fern *et al.*,(2002) suggested that video can serve as a stimulated learning environment which not only help learners to learn better, but also retain knowledge longer. This suggestion was echoed by the findings of Boateng *et al.*, (2016) in which more than half of the participated students in the research considered that videos provide a better and deeper understanding of the learning materials and in an easier way. Similarly, Brecht and Ogilby (2008) found 68.5% of research participants (students) considered that they understand information better through videos. Moreover, Brecht and Ogilby (2008) further argued that a potential benefit of video is that students can have additional processing time to understand the teaching materials. Wang (2016) further indicated that videos are associated with higher learner motivation. Moreover, videos are considered as an effective tool to enhance learner-to-learner interaction (DeLozier and Rhodes, 2017). On this, Bognar *et al.*,(2019) found that students were more engaged with the online discussion above videos than traditional teaching topics. The findings of Evans and Cordova (2015) showed a positive effect of videos on engagement and additional learning opportunities. Bruce and Chiu (2015) also indicated that group work and critical thinking can be improved by using videos. The study of Wieling and Hofman (2010) indicated that students'

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3 accomplishments improved significantly through video lectures. Although many previous  
4 works reported the benefits of microlearning and application of videos in supporting learning,  
5 only very few were conducted on discussing how learners prefer to interact with microlearning  
6 videos. This study can fill this knowledge gap.  
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10 The key significances of this study are summarised as follows. Firstly, the recent Covid-19  
11 pandemic has speeded up the adoption of online learning (Lockee, 2021). In this regard, the  
12 results of this study can inform how microlearning videos should be designed. This can also  
13 help higher education providers to provide better experience to learners and encourage  
14 performance improvement. Secondly, although the demand of microlearning is growing, there  
15 was lack of related studies. This study provides a reference for practitioners, researchers, and  
16 policy makers for possible future research and debates.  
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22 We considered the theoretical background of this study as follow: same as learning,  
23 microlearning is an information process, therefore it involves the use of learners' working  
24 memory. Accordingly, cognitive overload is a challenge in microlearning practice and how to  
25 minimise cognitive load should be taken into consideration in designing microlearning. In this  
26 regard, carefully designed multimedia microlearning can help to improve the use of limited  
27 cognitive load in learning. There are various ways to improve the design of multimedia  
28 microlearning. In this study, four interactive aspects have been identified as focus on this  
29 study, these are i) how the learners prefer to control the multimedia, ii) how the learners prefer  
30 to express themselves, iii) what is the preferred level of control in terms of attempting  
31 assessments, and iv) when the learners prefer to attempt assessment. We discuss these four  
32 aspects in the literature review section.  
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40 In this study, primary data was collected from the learners of three modules under two  
41 business programmes of a public University in the UK. The three modules of this study are  
42 offered under the Business School through two programmes: 1) BSc Accounting and Finance  
43 and 2) MSc Management.  
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47 In summary, the research question of this study is: "in what ways do learners prefer to interact  
48 with multimedia microlearning?" Moreover, five research objectives were developed as:  
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- 51 1. To review the key aspects of effective interactive multimedia microlearning.
- 52 2. To design and develop a questionnaire for collecting primary data in order to  
53 understand how learners would prefer to interact with multimedia microlearning.
- 54 3. To evaluate the collected primary data from the questionnaire in order to answer the  
55 research question.
- 56 4. To inform the design of an interactive multimedia microlearning project.
- 57 5. To widen the knowledge of microlearning practice.  
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The remainder of this paper is organised as follows. Section 2 comprehensively reviews the research trends of microlearning, followed by related theories of learning and multimedia learning. It also outlines the direction of this research. Section 3 critically explains the theoretical framework developed and research methodology adopted according to the literature review and the objectives of this study. Data presentation, analysis and findings are reported in section 4. Section 5 is the conclusions and recommendations of this study.

## 2. Literature review

According to a recent systematic review conducted by Leong *et al.*, (2020) which was based on 476 microlearning publications during 2006-2019, the findings suggested that microlearning is a relevantly new and emerging global topic involving authors, affiliations and funding sponsors from different countries. In addition, higher education has been found as the most frequently mentioned education level in the identified publications.

In practice, although using video can facilitate microlearning (Yousef *et al.*,2014; Delen *et al.*,2014), previous studies also indicated that the results of using video on supporting learning would be affected by various factors. For examples, Yee *et al.*, (2020) found that the engagement declined with video's time duration. Diwanji *et al.*, (2014) concluded that, instead of simply providing instructional materials, learners learn best by watching short videos. Vural (2013) suggested that video-based learning should be carefully designed and integrated interactive activities in order to improve engagement. Giannakos *et al.*, (2014) finds that combining video with other learning methods has great potential in providing learners with an integrated online learning space.

In brief, video should be carefully designed in order to achieve better microlearning results. On this, four interactive aspects have been identified as the focus in this study, these are i) how the learners prefer to control the multimedia, ii) how the learners prefer to express themselves, iii) what is the preferred level of control in terms of attempting assessments, and iv) when the learners prefer to attempt assessment. Five hypotheses were proposed according to these interactive aspects, and they are discussed as follows.

### 2.1 How learners prefer to control multimedia in a microlearning context

Allowing learners to control their learning progress and instructional materials have been considered as a promising solution (De Jong and Lazonder, 2005). In fact, the benefits of

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3 learner control are many. For example, Miller (1990) suggested learners with control feel more  
4 responsible for their own learning process. Lawless and Brown (1997) indicated that learner  
5 control enables learners to adapt the learning materials in their own cognitive needs.  
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9 Although the benefits of learner control have been studied widely, lack of related works are  
10 found in terms of how learners perceive the usefulness of learner control functions of  
11 microlearning videos. Perceived usefulness refers to the degree that how a user believes the  
12 use of a particular technology would enhance his or her performance. The understanding of  
13 perceived usefulness is important in this study because perceived usefulness affects learning  
14 results and learners' adoption in e-learning (Šumak *et al.*, 2011; Liaw and Huang, 2013;; Zhang  
15 *et al.*, 2017).  
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22 Wouters *et al.*, (2007) suggested that learner control involves different forms of interaction,  
23 including sequencing or selecting the content, or modifying the pace of presentation. The study  
24 also indicated the pause button is one of commonly used exemplar functions. Clark and Mayer  
25 (2016) summarised that one of the key principles is to always let learners set their pace of  
26 learning, such as allowing learners to pause or to set their speed during learning. Moreno and  
27 Mayer (2007) provided examples of learner control including: using a pause/play button,  
28 forward and back button and slider bar. The correlational relationship between the  
29 frequencies of long pauses and experienced difficulty in learning has been found in Li *et al.*  
30 (2015). Mayer and Pilegard (2014) suggested that presenting the learning materials in  
31 learner-paced segments would improve learning results rather than in a continuous flow.  
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40 Moreover, Salamé and Baddeley (1989) found the effects of background music on  
41 phonological short-term memory. Taylor *et al.*, (2009) proved the significance of the role of  
42 voices on mindfulness training. Hallam *et al.*, (2002) reported that the calming music led to  
43 better performance on tasks. Hooper *et al.*, (2007) found that changes of frame rate of learning  
44 videos had significant effects on learners' comprehension. Therefore,  
45 providing related functions for learners to control visual and audio content are expected to  
46 have positive impacts on perceived usefulness.  
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52 According to the above discussion, the first hypothesis is proposed as:

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55 **H<sub>1</sub>** Control function in microlearning videos is perceived as useful  
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58 In order to evaluate Hypothesis H<sub>1</sub>, nine functions are listed in this study (i.e. brightness,  
59 volume, speed, caption, playback bar, background music, pitch, resolution and play/pause). If  
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Hypothesis H<sub>1</sub> is supported, control function should be considered as a useful element in microlearning video – its related function should not be considered as a redundant element.

## 2.2 How learners prefer to express themselves in multimedia microlearning

Expressions are important parts of human communication. In learning context, learners' expressions are also key engagement activities. In this study, expression functions refer to the functions that allow learners to express their agreements, disagreements or thoughts on learning video contents.

In practice, different functions are available for users to express themselves about video content on social media. For example, the "like" function was considered as a tool to drive peer engagement with users (Harris and Dennis, 2011). Jensen *et al.*, (2003) suggested that "likes" represent self-expressive behaviour which is consistent with the personal element of users' engagement behaviour. Moreover, it manifests in users' positive affective responses or emotional relationship (Vernuccio *et al.*, 2015). In fact, the ability to "like" is one of the most common affordances of social media (Hayes *et al.*, 2016). Furthermore, counts of "like" can also be used to analyse audience reaction and emotion (Chung, 2015).

Other than the "like", according to Hwong *et al.*, (2017), comments are also some of the commonest ways that users engage with messages on social media. Verhoef *et al.*, (2010) suggested that comments are one of the behavioural manifestations that customers make on the content in the online context. Gummerus *et al.*, (2012) further indicated that a high-level frequency of comments is indicative of high-level of engagement, and the number of likes and comments on a social media content is a strong indicator and proxy for user engagement behaviour (Hoffman and Fodor, 2010). Similarly, He *et al.*, (2013) also concluded that a higher number of comments correspond to a higher level of user engagement.

Given expression is an important part of video's engagement, an e-learning platform enabling related functions for learners to express themselves are expected to have a positive impact on perceived usefulness. Therefore, according to the above discussion, the hypothesis is proposed as:

**H<sub>2</sub>** Expression function in microlearning video is perceived as useful

In order to evaluate the hypothesis H<sub>2</sub>, four expression functions are suggested in this study (i.e. like, dislike, subscribe and comment). Similar to H<sub>1</sub>, if H<sub>2</sub> is supported, expression function should be considered as a useful element in multimedia learning in microlearning approach.



## 2.3 What is the preferred level of control among learners in terms of attempting assessments

Microlearning video is a certain e-learning tool. Assessments are important in e-learning (Gaytan and McEwen, 2007). Kostons *et al.*, (2010) suggested that well designed assessments have positive impacts on student success and retention. In regards of the advantages of online assessments, Cairncross and Mannion (2001) summarised that online assessment can provide not only instant feedback but online assessment results can also be stored for further analysis. Furthermore, as per McKenna (2001), the flexibility of online assessment methods enables learners to engage with assessments anytime and anywhere. On this, Walker (2007) suggested that the time of online assessments should be carefully scheduled.

In terms of assessments, this study aims to examine if learners would prefer to have more control in the arrangement on their assessments. Moreover, two types of assessments, i) multiple choice questions and ii) open-ended questions are commonly used in practice. Therefore, two new hypotheses are proposed as:

**H<sub>3</sub>** Learners prefer to have more control in the arrangement on their multiple-choice questions

**H<sub>4</sub>** Learners prefer to have more control in the arrangement on their open-ended question's

In addition, a further hypothesis is proposed as:

**H<sub>5</sub>** Learners would have preferred time to attempt session assessment when they attend session

## 3. Research Methodology

This section begins with section 3.1 which reports the population and its background of this study. Section 3.2 focuses on data collection. The data collection methods, corresponding tools are compared and contrasted in this section. In addition, questionnaires were selected as the data collection tool in this study. The design of the questionnaire is explained in this section 3.3. Section 3.4 explains the data analysis and corresponding tools.

### 3.1 Population, sample and its background

Data for this study was collected from the learners of three modules under two business programmes of a public University in the UK. The three modules of this study are offered under



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3 the Business School through two full time programmes, a) BSc Accounting and Finance and  
4 b) MSc Management. The sample was selected because they were the groups which the  
5 researchers were able to connect with during teaching. This study can be extended to learners  
6 from different backgrounds in future study.  
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### 10 3.2 Data collection method

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12 A self-developed questionnaire was used in this study for data collection purposes. The  
13 questions were developed from the material discussed in the literature review, this includes in  
14 section 1, questions related to control function were supported by Wouters *et al.*,(2007); in  
15 section 2 and 3, questions related to preferred level of control were supported by Kostons *et*  
16 *al.*,(2010); in section 4, question about time to attempt assessment was supported by Walker  
17 (2007) and questions related to perceived usefulness of expression were supported by  
18 Hoffman and Fodor (2010). A pilot questionnaire was developed to collect feedback from the  
19 corresponding colleague and selected student representatives about the questionnaire. The  
20 purpose of the pilot questionnaire is to evaluate how potential participants may understand  
21 the questionnaire and whether potential participants may feel pressure to answer the  
22 questions. The pilot questionnaire has also been used to evaluate whether potential  
23 participants interpret the questions as per the design purpose.  
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31 This research took place online and Microsoft Forms (MS Forms) was used as the platform of  
32 the questionnaire.  
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35 In order to recruit participants, all learners who were enrolled into the relevant three modules  
36 were contacted directly by the researchers through the learners' email. More specifically, the  
37 email contains the web link of the questionnaire. The data collected from MS forms were  
38 exported to Microsoft Excel and then to SPSS for further analysis purposes.  
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42 This study was conducted in compliance with the University's (the researcher's employer)  
43 Code of Practice on Research Ethics and Governance. Before the fieldwork started, formal  
44 Ethical Approval for this research study had been obtained on 5th February 2021 from the  
45 Faculty's Ethics Committee of the University where data is collected.  
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### 51 3.3 Design of the questionnaire

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53 The questions in the questionnaire were self-developed according to the identified aspects  
54 discussed in the literature review as explained in Section 3.2. As mentioned earlier, pilot test  
55 on the questionnaire had been conducted to ensure the validity. We used closed-ended  
56 questions as the main body of the questionnaire. In addition, two open-ended questions were  
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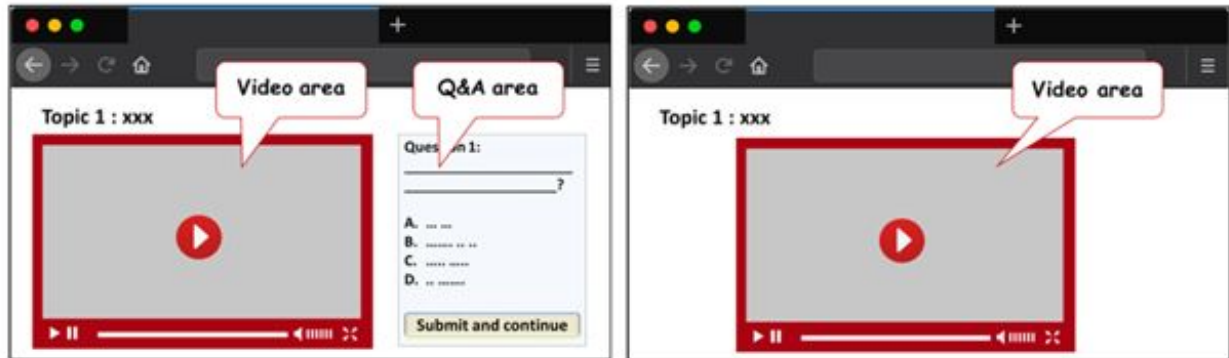
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3 included with the purpose to enable participants to share their views. The views were  
4 compared with their selected options in other questions to ensure the level of consistency.  
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7 In terms of the structure, the questionnaire consists of two major parts. The first part is a  
8 participant information and consent form. The second part of the questionnaire has five  
9 sections as follows.  
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12 In section 1, participants are required to rate the usefulness of nine control functions  
13 (brightness, volume, speed, caption, playback bar, background music, pitch, resolution and  
14 play/pause) as per hypothesis 1 ( $H_1$ ). The section starts with a short background statement  
15 which assumes participants are learning with a 5-10 minute educational video, and then the  
16 participants are required to rate nine 5-point Likert type questions (the 5 options are: not useful  
17 at all, slightly useful, moderately useful, very useful, and extremely useful). Each question  
18 refers to a control function according to hypothesis 1 ( $H_1$ ). The hypothesis proposes that  
19 control function in multimedia microlearning are perceived as useful.  
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26 As per Figure 1, section 2 starts with a scenario which assumes participants are learning with  
27 a 5-10 minute educational video which contains a multiple choice question. The participants  
28 can also find two different multiple choice question arrangements, design A and design B.  
29 They are required to select their preferred design. This question was designed with the aim to  
30 collect data for evaluating the hypothesis 3 ( $H_3$ ). In addition, participants have also been invited  
31 to explain why they prefer the design. This open-ended explanation is an optional question,  
32 aiming to gather further qualitative insights from the participants.  
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You are given a 5 to 10 minute educational video and the video contain a multiple choice question. In terms of the multiple choice question arrangement, please select your preferred design (A or B) as shown in the below diagrams and descriptions.



**Design A**

This design has two areas, video area and Q&A area. The multiple choice question is arranged as follows:

- 1) You are watching the video
- 2) The video pauses and the question appears on the Q&A area.
- 3) You are required to choose the answer, then click the "submit and continue" button.
- 4) The answer and explanation are provided in the Q&A area
- 5) The video continues with remaining content.

**Design B**

This design has one area, the video area. The multiple choice question is arranged as follows:

- 1) You are watching the video
- 2) The question is asked inside the video
- 3) After a few seconds of waiting
- 4) The answer is provided and explained in the video.
- 5) The video continues with remaining content.

*Figure 1. Section 2 of the questionnaire*

As per Figure 2, the layout of section 3 is similar to section 2. In section 3, participants are introduced with a scenario which assumes they are learning with a 5-10 minute educational video and the video contains an open-ended question. The participants can also find two different open-ended question arrangements, design A and design B. They are required to select their preferred design. This question was designed with the aim to collect data for evaluating the hypothesis 4 ( $H_4$ ). Moreover, participants have a chance to explain why they prefer the design in an optional question, aiming to gather further qualitative insights from the participants.

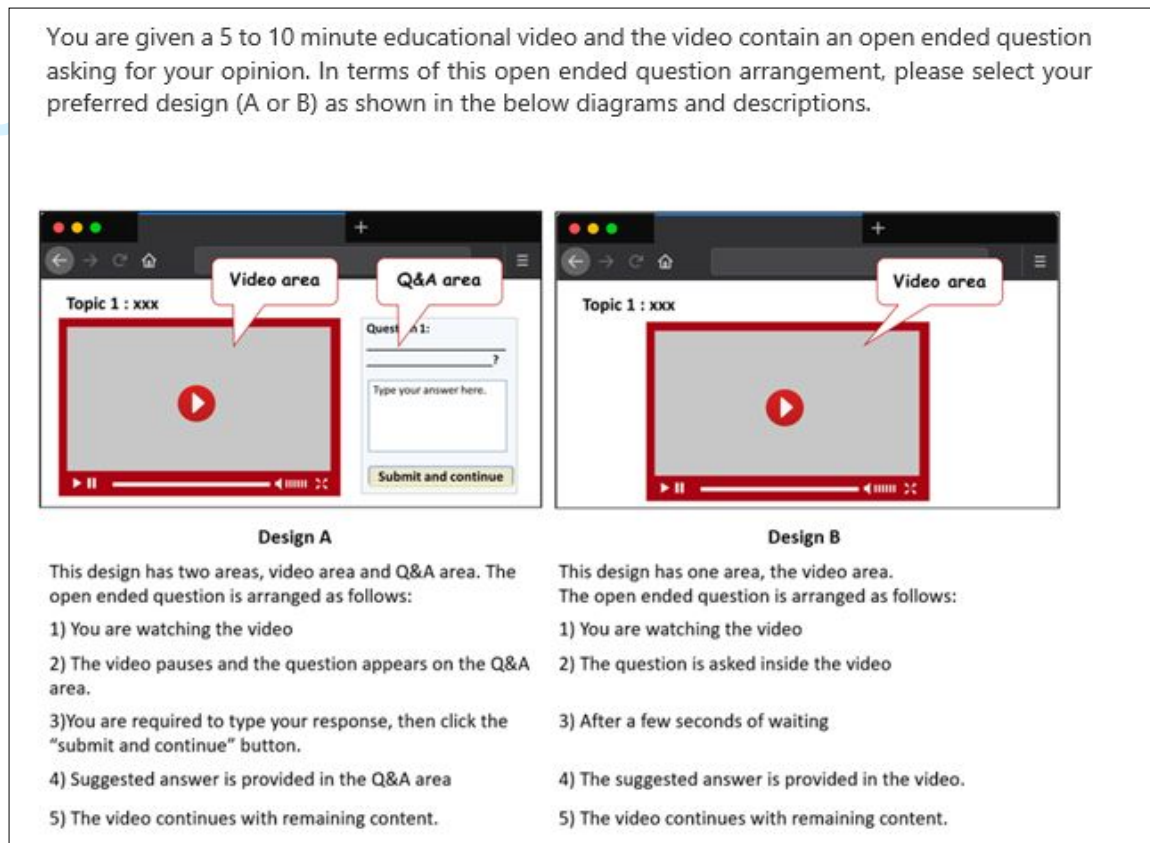


Figure 2. Section 3 of the questionnaire

Section 4 consists of two sets of questions. The first set of questions provides a scenario to participants that when they are given a 5 to 10 minute education video and the video contains a few questions, asking them how they like the questions be arranged. There are two options for participants to choose: i) questions to be asked at the end of the video and ii) questions to be asked during the video. This question aims to evaluate whether learners would have preferred time to attempt session assessment when they attend sessions as per hypothesis 5 ( $H_5$ ).

Moreover, in the second set of question in the section 4, another scenario is provided to the participants. The scenario assumes that videos are used to deliver teaching, how the participants would rate a list of expression function (i.e. like, dislike, subscribe and comment). The participants are required to rate four 5-point Likert type questions (the 5 options are: not useful at all, slightly useful, moderately useful, very useful, and extremely useful). Each question refers to an expression function according to hypothesis 2 ( $H_2$ ). The hypothesis proposes that expression function in multimedia microlearning are perceived as useful.

Section 5 is the last section and covers a range of demographic questions of the participants.

### 3.4 Data analysis and corresponding tools

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3 In this research, median is used, instead of mean, to measure the central tendency of the  
4 findings of the sample. In comparison, mean is more suitable for measuring central tendency  
5 of continuous data while median should be used when categorical data are ranked in order.  
6 For example, in this research, the ratings of control or expression functions are ranked from  
7 lowest rating 'not useful at all' to highest rating 'extremely useful'. Therefore, median is used  
8 instead of mean in this study. Furthermore, mode is used to report the measure that appears  
9 most often in the sample.  
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15 In order to conclude whether the findings from the sample related to hypotheses are  
16 statistically significant, Chi-square is used in this study, instead of other techniques because  
17 chi-square test is a nonparametric test that compare the observed data distribution with  
18 expected data distribution (Rana and Singhal, 2015). Nonparametric tests are referred to as  
19 distribution-free test which do not require normal distribution of data. Nonparametric test is  
20 more suitable, the reason is normal distribution of data should not be expected because Likert  
21 data was used in this study. As per Boone and Boone (2012), Likert data expresses a 'greater  
22 than' relationship but how much greater cannot be implied, therefore, normal distribution will  
23 not be happen and Chi-square test should be adopted.  
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#### 30 **4. Data presentation, analysis and findings**

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32 This section reports the findings based on an online survey by means of online questionnaire  
33 conducted from 18 February to 4 March 2021 (2 weeks). The findings aim to evaluate the five  
34 proposed hypotheses ( $H_1$  to  $H_5$ ).  
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##### 38 **4.1 Demographic characteristics of the population and the participants**

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40 In total, the invitation had been sent to all 236 enrolled learners from the 3 targeted modules  
41 through emails. 77 participants completed the survey with the response rate 32.6%.  
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44 Among the 77 participants, there are 43 postgraduates (56%) and 34 undergraduates (44%).  
45 In addition, the participants consist of 41 male participants (53%) and 36 female participants  
46 (47%). Moreover, the distribution of the age groups is aged 17-21 (23 participants, 30%), 22-  
47 26 (30 participants, 39%), 27-35 (19 participants, 25%) and 36-60 (5 participants, 6%). The  
48 age range starts at 17 because there are international students who starts their study at 17.  
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##### 52 **4.2 Descriptive analysis of the preferred interaction among the participants**

###### 53 **- The perceived usefulness of control functions in multimedia microlearning ( $H_1$ )**

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55 The rating results from the 77 participants on the nine multimedia control functions are shown  
56 in the bar charts as per Figure 3. These ratings reflect the perceived usefulness of these  
57 functions. Table 1 summarises the medians and modes of the corresponding control functions.  
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As per the table, all the medians of the control functions are rated as 3 (moderately useful) or above in which play/pause function has the highest median result (i.e. 5, extremely useful). Overall, the results indicate the perceived usefulness of the control functions in multimedia microlearning are generally high.

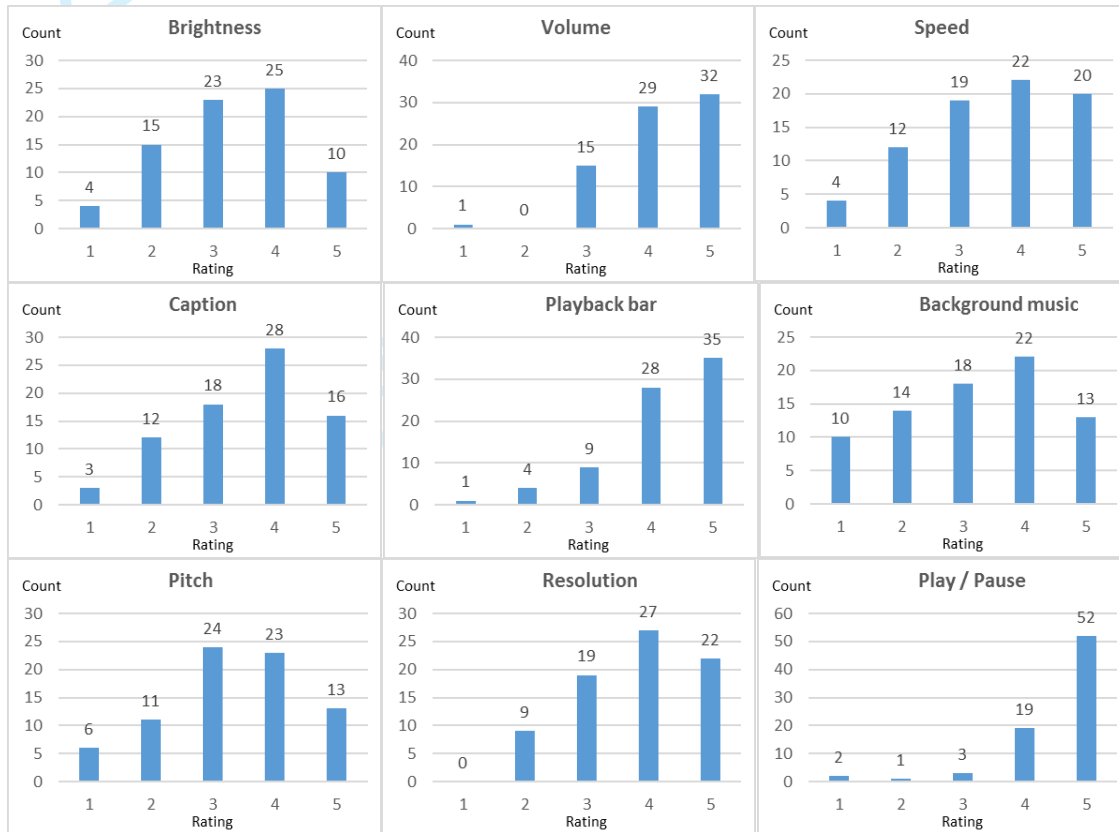


Figure 3. The counts and ratings of the 9 multimedia control functions of participants (rating at 1 represents not useful at all; rating at 5 represents extremely useful)

	Brightness	Volume	Speed	Caption	Playback bar	Background music	Pitch	Resolution	Play/pause
Median	3	4	4	4	4	3	3	4	5
Mode	4	5	4	4	5	4	3	4	5

Table 1. Medians and modes of the corresponding 9 control functions

**The perceived usefulness of expression functions in multimedia microlearning (H<sub>2</sub>)**

The preferences of expression functions are summarised in Figure 4. In addition, Table 2 summarises the medians and modes of each expression function. As per the figure and the table, all the medians of the interactive functions are rated as 3 (moderately useful) or above. Overall, the results indicate the perceived usefulness of the expression functions in multimedia microlearning are at least moderately useful or above.



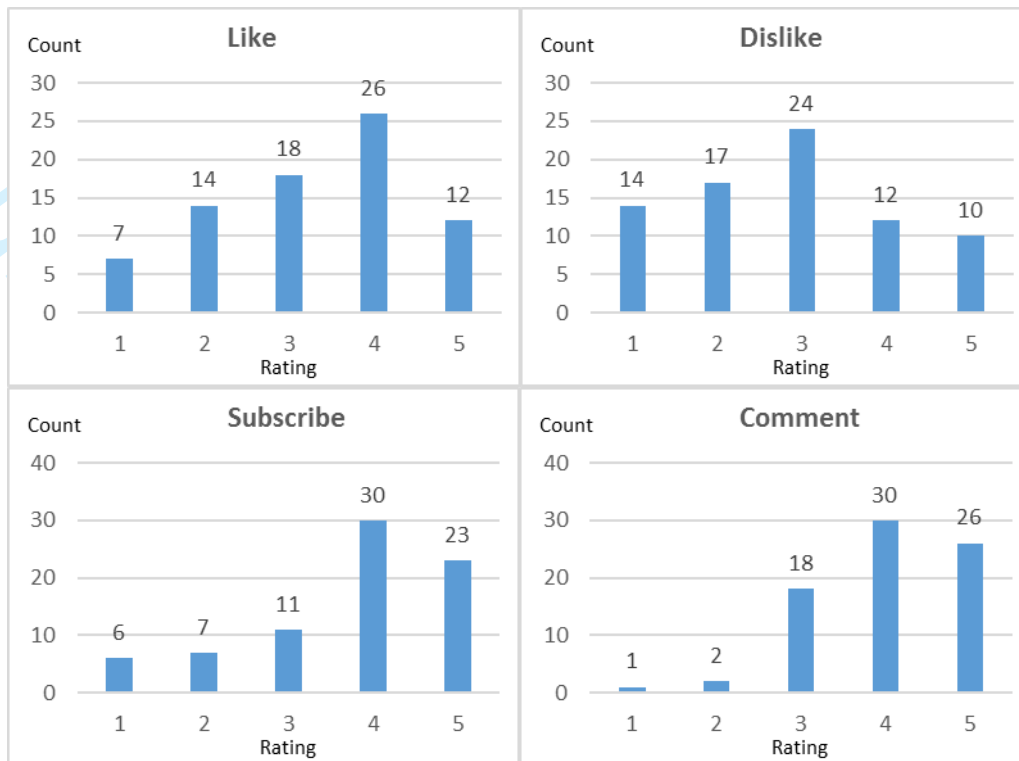


Figure 4. The counts and ratings of perceived usefulness of the 4 expression functions of participants (rating at 1 represents not useful at all; rating at 5 represents extremely useful)

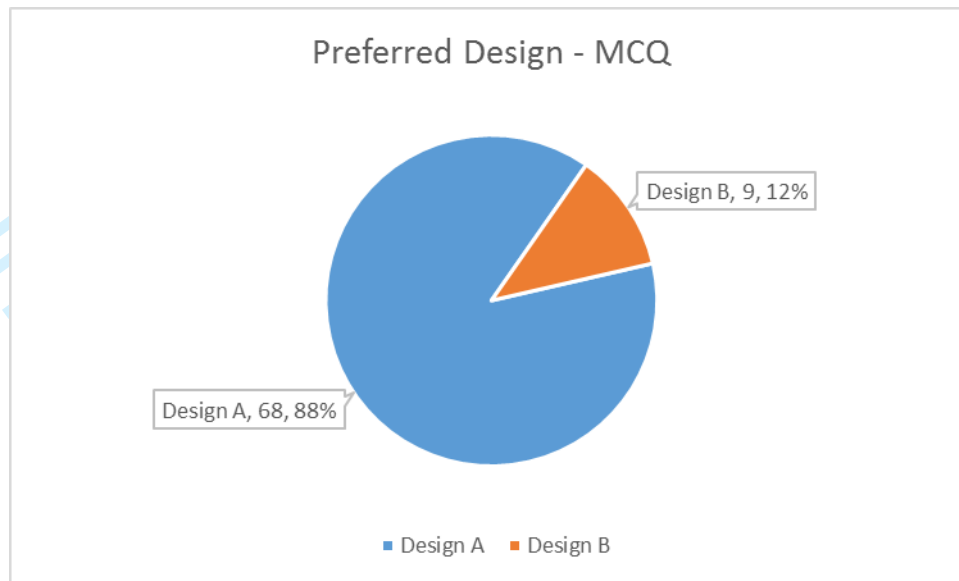
	Like	Dislike	Subscribe	Comment
Median	3	3	4	4
Mode	4	3	4	4

Table 2. Medians and modes of the corresponding 4 expression functions

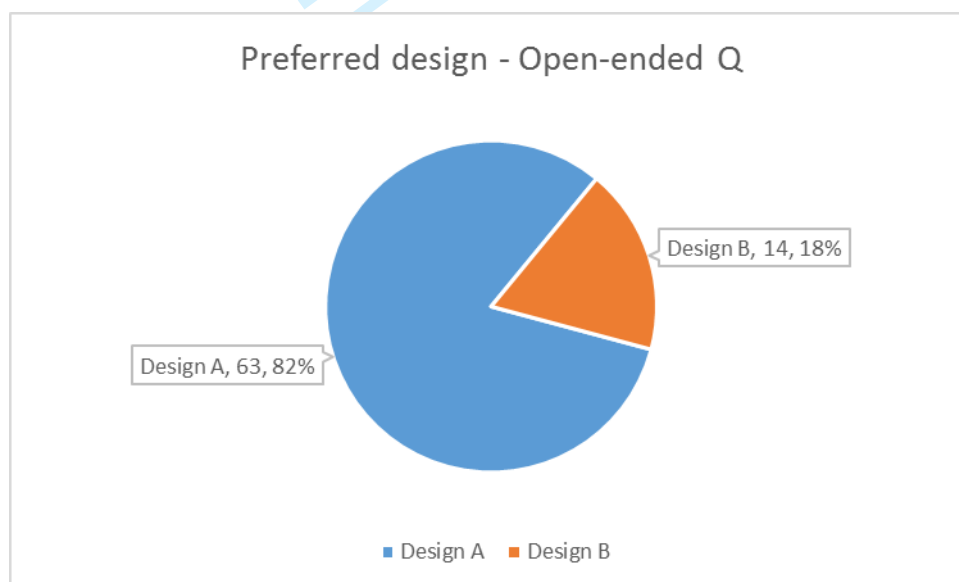
- **The preferred level of control in terms of attempting multiple choice and open-ended question's arrangement (H<sub>3</sub> and H<sub>4</sub>)**

In terms of the design of assessment arrangements, Figures 5 and 6 show a summary of the choices among the participants. Both results indicate that more participants prefer the design arrangements allowing them to have higher level of control. For multiple choice questions, 68 participants (88%) out of 77 participants chose the design arrangement allowing them to have more control (design A), while for the open-ended question, 63 participants (82%) out of 77 participants chose the design arrangement allowing them to have more control (design A).





22 *Figure 5. Preference on design in relation to multi-choice question arrangement*



45 *Figure 6. Preference of design in relation to open-ended question arrangement*

46 Two open-ended questions were also arranged for allowing participants to share their views  
47 on why they prefer the selected designs. Overall, the feedback from the questions are in line  
48 with the corresponding design selected. For example, for a participant selected design A, the  
49 participant also provided a comment in line with Design A as "*Design A requires feedback and*  
50 *seems much more responsive.*" The following paragraph is a summary of comments according  
51 to the designs.

52 For the participants selected Design A, easy-to-use, sense of control and encourage  
53 participation, are general thoughts. Some relevant example comments include, "*Option A*  
54 *allows you to critically evaluate your understanding of the video content. Personally I have*  
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experienced both and i prefer option A style”, “The video gets paused and question directly asked at the Q&A, It is clearer this way and I can choose my answers vividly”, “It’s easy for participant in same time to watch video and follow the question” and “I prefer the text box design as it allows me to check what I had typed”, etc.

For the participants who selected Design B, visual experience was the key reason. Some relevant example comments include, “Clearer”, “I like to big screen” and “So you don’t have to struggle looking at the screen as well as the questions on the side”, etc.

#### - **The preference of when to attempt assessment (H<sub>5</sub>)**

In terms of how participants like the questions would be arranged, Figure 7 shows that more participants (42 or 55%) prefer the questions to be asked during the video rather than after the video (35 or 45%).

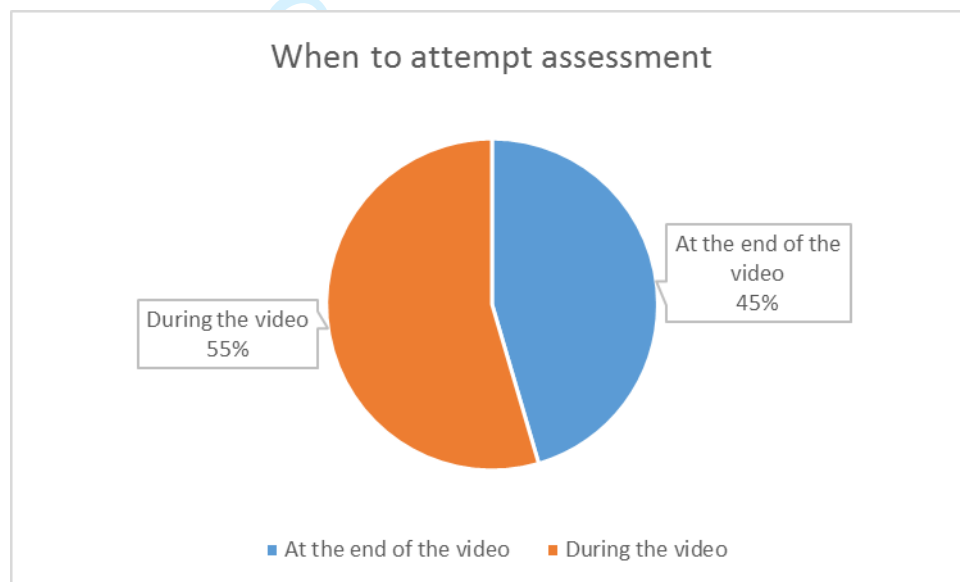


Figure 7. The preference of when to attempt assessment

As mentioned earlier, two open-ended questions were included with the purpose to enable participants to share their views. The views were compared with their selected options in other questions to ensure the level of consistency. According to our findings, we considered no contradictions between the participants’ selected options and their open-ended answers.

### 4.3 Significance tests of the preferred interactions

Significance tests were conducted to evaluate if the findings related to Hypotheses 1 to 5 are of statistical significance.

#### - **Significance test for hypothesis 1 (perceived usefulness of control functions)**

The findings reported in the previous section indicate that control function in microlearning video are perceived as useful.

One-sample Chi-Square test was conducted to examine whether the findings are statistical significance. As per Table 3, by comparing with expected distribution of the ratings occurring with equal probabilities, the observed ratings of perceived usefulness of all the control functions are supported ( $p < 0.05$ ). Therefore, the null hypothesis 1 is rejected. Accordingly, it concludes that control functions in multimedia learning are perceived as useful in an assumed microlearning video.

#### Hypothesis Test Summary

Category: Usefulness of	Sig.
Brightness	0.000
Volume	0.000
Speed	0.000
Caption	0.000
Playback	0.000
Background music	0.000
Pitch	0.000
Resolution	0.000
Play/pause	0.000

Note: The category occurs with equal probabilities. Test: One-sample Chi Square Test. The significance level is 0.05

*Table 3: Summary of hypothesis 1 testing using Chi-square test on the usefulness of the 9 multimedia control functions*

The findings and hypothesis results are in line with previous studies. In fact, previous results have indicated that giving control to learners have positive impacts on their learning. As per Miller (1990), learners with control feel more responsible for their own learning process. Betrancourt (2005) indicated that learners reported greater interest on the learning video with control.

#### - **Significance test for hypothesis 2 (perceived usefulness of expression functions)**

The findings reported in the previous section indicate that expression function in microlearning videos are perceived as useful.

One-sample Chi-Square test was conducted to examine whether the findings are statistical significance or not. As per Table 4, by comparing with expected distribution of the ratings occur with equal probabilities, the observed ratings of perceived usefulness of all the control functions are supported (like, subscribe and comment,  $p < 0.05$ ) and dislike ( $p < 0.1$ ). Therefore,

the null hypothesis 2 is rejected. Accordingly, it concludes that expression functions in microlearning videos are perceived as useful.

Category: Usefulness of	Sig.
Like	0.000
Dislike	0.087
Subscribe	0.000
Comment	0.000

Note: The category occurs with equal probabilities. Test: One-sample Chi Square Test. The significance level is 0.1

*Table 4. Summary of hypothesis 2 testing using Chi-square test on the 4 expression functions*

Previous studies (Harris and Dennis, 2011; Verhoef *et al.*, 2010) reported the positive relationships between various expression functions and user engagement, the findings and hypothesis results appear consistent with previous studies.

- **Significance test for hypothesis 3 (preferred level of control in terms of attempting multiple choice question's arrangement)**

Results reported in the previous section indicates that learners prefer to have more control in the arrangement on their multiple-choice questions.

One-sample Chi-Square test was conducted to examine whether the result is statistical significance or not. As per Table 5, by comparing with expected distribution of the choice occur with equal probabilities, the observed choice is supported ( $p < 0.05$ ). Therefore, the null hypothesis 3 is rejected. Accordingly, it concludes that learners prefer to have more control when they attempt multiple choice questions in the assumed context.

Null Hypothesis:	Sig.
The categories of Design -MCQ occur with equal probabilities	0.000

*Table 5. Summary of hypothesis 3 testing using Chi-square test on participants' design preference on multi-choice question arrangement*

- **Significance test for hypothesis 4 (preferred level of control in terms of attempting open-ended question's arrangement)**

Result reported in previous section indicates that learners prefer to have more control in the arrangement on their open-ended questions.

One-sample Chi-Square test was conducted to examine whether the result is statistical significance or not. As per Table 6, by comparing with expected distribution of the choice occurs with equal probabilities, the observed choice is supported ( $p < 0.05$ ). Therefore, the null hypothesis 4 is rejected. Accordingly, it concludes that learners prefer to have more control when they attempt open-ended questions in the assumed context.

Null Hypothesis:	Sig.
The categories of Design – open ended question occur with equal probabilities	0.000

Table 6. Summary of hypothesis 4 testing using Chi-square test on participants' design preference on open-ended question arrangement

Previous studies (Al-Samarraie *et al.*, 2013; Sung *et al.*, 2011) stressed the importance of interface design on learners' learning. For both significant tests for Hypotheses 3 and 4, results also indicate learners prefer the interfaces having more control when they attempt assessments in both multiple choice questions and open-ended questions. Accordingly, the test results provide some guidelines on interface design on supporting learning.

#### - **Significance test for hypothesis 5 (preference of when to attempt assessment)**

Result reported in previous section indicates that learners would have preferred time to attempt session assessment when they attend sessions.

One-sample Chi-Square test was conducted to examine whether the result is statistical significance or not. As per Table 7, by comparing with expected distribution of the choice occurs with equal probabilities, the observed choice is not supported ( $p < 0.05$ ). Therefore, the null hypothesis 5 is not rejected. Accordingly, conclusion cannot be made in terms of whether learners have a preference for preferred time to attempt session's assessment when they attend session.

Null Hypothesis:	Sig.
The categories of questions to be arranged with equal probabilities	0.425

Table 7. Summary of hypothesis 5 testing using Chi-square test on participants' preference on when to attempt assessment

Although previous study (Kelley *et al.*, 2015) indicated that time is a key variable in learning related studies, the significant test for Hypotheses 5 found that there was no evidence to show learners have preferred time to attempt sessions assessment when they attend sessions. This

is possible because microlearning involves short learning duration time and therefore, when to attempt the assessments was not a concern for learners.

## 5. Discussion

Technology has significantly changed learners' experiences (Sung *et al.*, 2020; Leong & Sung, 2022). This study aims to explore how learners prefer to interact with microlearning videos. The knowledge generated from this study fills the knowledge gap in the field of microlearning. The key findings of this study are summarised in Table 8.

Hypothesis	Description	Findings	Significant test results
1	The perceived usefulness of control functions in multimedia learning	The perceived usefulness of the control functions are generally high	Support the hypothesis
2	The perceived usefulness of expression functions in multimedia learning	The perceived usefulness of the expression functions are generally high	Support the hypothesis
3	The preferred level of control in terms of attempting multiple choice question's arrangement	More participants prefer to have more control in their multiple choice question's arrangement	Support the hypothesis
4	The preferred level of control in terms of attempting open ended question's arrangement	More participants prefer to have more control in their open ended question's arrangement	Support the hypothesis
5	The preference of when to attempt assessment	More participants prefer the questions to be asked during the video rather than after the video	Not support the hypothesis

Table 8. Summary of hypotheses and findings

This study aims to answer the question "*in what ways do learners prefer to interact with multimedia microlearning?*" The knowledge generated from this study fills the knowledge gap in the field of microlearning. Table 9 summarises the research objectives and how the objectives have been addressed in this study.

Research objectives of this study	How the objectives have been addressed in this study
1. To review the key aspects of effective interactive multimedia microlearning	In section 2, the aspects are classified into different interactive aspects according to existing literature. Accordingly, five hypotheses were proposed.
2. To design and develop a questionnaire for collecting primary data in order to understand	In section 3, data collection and analysis methods and tools were compared and



how learners prefer to interact with multimedia microlearning.	contrasted. The design and administration of the questionnaire was justified.
3. To evaluate the collected primary data from the questionnaire in order to answer the research question.	In section 4, the collected primary data were analysed and used to test the hypothesis 1-7.
4. To inform the design of interactive multimedia microlearning project	Implications of the study were reported in section 5.
5. To widen the knowledge of microlearning practice.	New knowledge was created from this study which contributes to the field of microlearning.

*Table 9. Summary of the research objectives and how the objectives have been addressed in this study*

Moreover, according to the analysis of primary data collected from our participants, the following implications are offered.

**Implication 1:** Control functions should be included in the multimedia microlearning project. Every learner is different and may have a different learning style. Some learners can read faster and some learners can perform better with audio messages. Including control functions in multimedia microlearning enables different learners to learn in their own styles and pace. Nine control functions (i.e. brightness, volume, speed, caption, playback bar, background music, pitch, resolution and play/pause) were proposed and evaluated in this study. All these functions should be included when designing the videos for supporting multimedia microlearning purpose.

**Implication 2:** Expression functions should be included in the multimedia microlearning project. Unlike face-to-face learning which learners can interact with peers and lecturers in person, learners may feel remote and lonely in online learning environment. Including expression functions in multimedia microlearning enables learners to develop the feeling of participation in their learning journey. Four expression functions (i.e. like, dislike, subscribe and comment) were proposed and evaluated in this study. All these functions should be included in the design of microlearning videos.

**Implication 3:** Assessment is a key component in learning and there are two major types of assessments: closed-ended and open-ended. As mentioned above in implication 1, every learner may have a different learning style. According to the findings and significance tests of this study, the multimedia microlearning project not only enables learners to control how they learn, but the interface of assessments should also be designed in a way in order to enable learners to have higher level of controls, this implication applies to both closed-ended and open-ended types of assessments.



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3 **Implication 4:** In practice, small activities can help to engage learners and enhance learning  
4 experience. For example, a quick check can draw learners' attention and ensure they are in  
5 the same page with the content. Given no obvious pattern was found from this study in terms  
6 of when the participants prefer the questions to be asked, therefore, interactive activities can  
7 be freely arranged during the videos or after the videos according to the instructional design  
8 and training need. For any assessment in a microlearning video, it can be arranged during the  
9 videos and does not necessarily require to wait for the video to complete.

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15 In addition, we identified the major limitations in this research as follows.

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19 - Likert types items

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22 In the questionnaire, for the questions on control functions and expression functions, answers  
23 from participants were collected as Likert type items. Likert type items are ordinal data. In  
24 practice, ordinal data is classified into categories and has a natural rank order. However, it's  
25 worth mentioning that there is no standardised interval scale of measurement between  
26 categories in Likert type items. The reason is that the answer options may be interpreted  
27 differently by different participants. A 'strongly agree' option by a participant could be referred  
28 as 'agree' by another participant. Accordingly, a common challenge of analysing Likert data  
29 from questionnaires is that the difference in variation cannot be concluded if ordinal scale is  
30 used. In order to overcome the challenge, non-parametric tests were used in this research  
31 with the aims to minimise the potential negative impacts on analysing findings. Non-parametric  
32 tests had been considered as appropriate for analysing ordinal data because the tests do not  
33 assume a normal distribution.

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43 - Longitudinal effects

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46 Another limitation in this study is that the findings collected from participants may vary from  
47 time to time. In fact, it is not easy to measure changes in the population unless more surveys  
48 are conducted at different time points. However, it is believed that the current research  
49 provides insights into the most up-to-date context. Further follow-up research is also  
50 recommended to be conducted to monitor the results for any longitudinal effects.

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56 - Depending on quantitative findings

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3 Only very few open-ended questions were arranged in this research due to time and resources  
4 constraints. In future follow-up research, interviews with more open-ended questions can be  
5 arranged to obtain deeper understandings to related issues.  
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### 9 5.1 Recommendations for future research

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11 Other than the above mentioned implications, the findings raised by this current research  
12 also indicate several suggestions for future research.  
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15 Firstly, cross-disciplinary research could be conducted in order to provide new insights from  
16 different perspectives on how learners interact with multimedia microlearning interface design.  
17 For example, applications of electroencephalogram (EEG) and eye tracking. These  
18 technologies have widely been used in psychology studies in recent years. On this, conducting  
19 further research together with experts from other disciplines can help to generate new  
20 knowledge on multimedia microlearning video design.  
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23 Secondly, this study was conducted in the UK, the current study can be extended to learners  
24 from different backgrounds, such as from different countries and different socio-economic  
25 backgrounds in order to critically compare and contrast the findings. The comparisons can  
26 inform how to implement multimedia microlearning effectively in different cultures and for  
27 different socio-economic backgrounds.  
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30 Hopefully, this study could shed some lights on future research in the field of microlearning  
31 and work-based learning.  
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## Appendix – Sample of the questionnaire

### Section 1 of 5

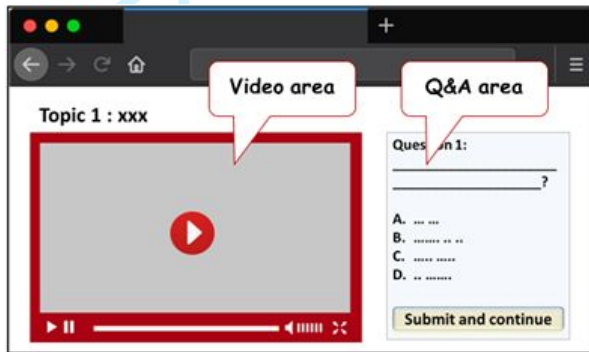
Q1. Assume there is a 5-10 minute educational video. How would you rate the usefulness on the functions listed below?

For each Item below, please tick the most representable option.

	Not useful at all	Slightly useful	Moderately useful	Very useful	Extremely useful
Brightness (You are able to adjust the brightness of the video, such as making the video bright or dim)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Volume (You can adjust the volume of sound – loud to quiet to mute)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Speed (You can control the video to play faster or slower)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Caption (You are able to control whether or not to display the caption on screen, which is the transcript of the video)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playback bar (You can go to different point in the video)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Background music (You can adjust whether or not to play the background music)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Pitch (You can adjust the pitch of sound – high pitch to low pitch.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Resolution (You are able to adjust the sharpness or the video or quality of the video.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Play/pause (you can play and pause the video)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Section 2 of 5

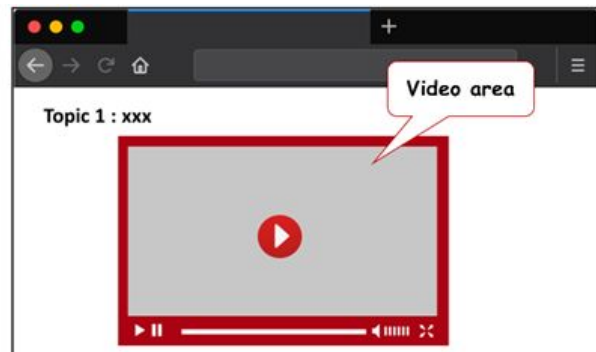
You are given a 5 to 10 minute educational video and the video contain a multiple choice question. In terms of the multiple-choice question arrangement, please select your preferred design (A or B) as shown in the below diagrams and descriptions.



**Design A**

This design has two areas, video area and Q&A area. The multiple choice question is arranged as follows:

- 1) You are watching the video
- 2) The video pauses and the question appears on the Q&A area.
- 3) You are required to choose the answer, then click the "submit and continue" button.
- 4) The answer and explanation are provided in the Q&A area
- 5) The video continues with remaining content.



**Design B**

This design has one area, the video area.

The multiple choice question is arranged as follows:

- 1) You are watching the video
- 2) The question is asked inside the video
- 3) After a few seconds of waiting
- 4) The answer is provided and explained in the video.
- 5) The video continues with remaining content.

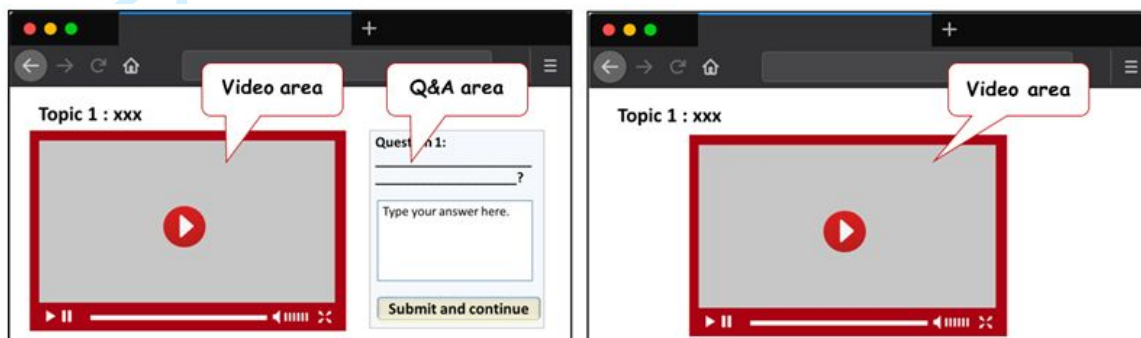
Q3. Which one of the designs would you prefer for multiple choice questions?

- Design A
- Design B

Q4. Why do you prefer this design for multiple choice questions? (optional)

## Section 3 of 5

You are given a 5 to 10 minute educational video and the video contain an open ended question asking for your opinion. In terms of this openended question arrangement, please select your preferred design (A or B) as shown in the below diagrams and descriptions.



**Design A**

This design has two areas, video area and Q&A area. The open ended question is arranged as follows:

- 1) You are watching the video
- 2) The video pauses and the question appears on the Q&A area.
- 3) You are required to type your response, then click the "submit and continue" button.
- 4) Suggested answer is provided in the Q&A area
- 5) The video continues with remaining content.

**Design B**

This design has one area, the video area. The open ended question is arranged as follows:

- 1) You are watching the video
- 2) The question is asked inside the video
- 3) After a few seconds of waiting
- 4) The suggested answer is provided in the video.
- 5) The video continues with remaining content.

Q5. Which one of the designs would you prefer for open ended questions?

- Design A
- Design B

Q6. Why do you prefer this design for open ended questions? (optional)

## Section 4 of 5

Q7. You are given a 5 to 10 minute educational video and the video contains a few questions  
How would you like the questions be arranged? Single choice.

- Questions to be asked at the end of the video
- Questions to be asked during the video

Q8. Assume that videos are used to deliver teaching. How would you rate the following functions on helping you to engage in learning? The functions are like, dislike, subscribe and comment.

	Not useful at all	Slightly useful	Moderately useful	Very useful	Extremely useful
Like - this function enables you to like the video	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dislike - this function enables you to dislike the video	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Subscribe - this function enables you to get notice on any new published videos of the course / module	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comment - this function enables you to leave your comment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## Section 5 of 5

Q9. What is your gender?

- Male
- Female
- Others
- Prefer not to answer

Q10. Your age group Single choice.

- 17-21
- 22-26
- 27-35
- 36-60
- 61 or above
- Prefer not to answer