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A study of learners' interactive preference on multimedia microlearning

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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.

Design/methodology/approach – A questionnaire was used in this study for data collection purposes. In total, the invitation had been sent to 236 enrolled learners from the three targeted modules through emails. A total of 77 participants completed the survey with the response rate of 32.6%. The chi-square test 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 United Kingdom (UK) university, the findings suggest that 1) the perceived usefulness of the control functions and the expression functions of multimedia microlearning videos are generally high and 2) more participants, on the one hand, prefer to have more control in their multiple-choice questions' arrangement and open-ended questions' arrangement; on the other hand, there was no significant difference on the preference of when to attempt assessment.

Originality/value – 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.

Keywords E-learning, Assessments, Video, Microlearning, Multimedia

Paper type Research paper

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 to up-to-date information were preferred by managers. According to Emerson and Berge (2018), on the one hand, 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

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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 the 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 videos can serve as a stimulated learning environment which not only helps 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 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' accomplishments improved significantly through video lectures. Although many previous works reported the benefits of microlearning and application of videos in supporting learning, only very few were conducted on discussing how learners prefer to interact with microlearning videos. This study can fill this knowledge gap.

The key significances of this study are summarised as follows. First, the recent Covid-19 pandemic has speeded up the adoption of online learning (Lockee, 2021). In this regard, the results of this study can inform how microlearning videos should be designed. This can also help higher education providers to provide better experience to learners and encourage performance improvement. Second, although the demand of microlearning is growing, there was a lack of related studies. This study provides a reference for practitioners, researchers and policymakers for possible future research and debates.

We considered the theoretical background of this study as follows: same as learning, microlearning is an information process; therefore, it involves the use of learners' working memory. Accordingly, cognitive overload is a challenge in microlearning practice and how to minimise cognitive load should be taken into consideration in designing microlearning. In this regard, carefully designed multimedia microlearning can help to improve the use of limited cognitive load in learning. There are various ways to improve the design of multimedia microlearning. In this study, four interactive aspects have been identified as focus on this study: these are 1) how the learners prefer to control the multimedia, 2) how the learners prefer to express themselves, 3) what is the preferred level of control in terms of attempting assessments and 4) when the learners prefer to attempt assessment. We discuss these four aspects in the literature review section.

In this study, primary data were collected from the learners of three modules under two business programmes of a public university in the United Kingdom (UK). The three modules of this study are offered under the Business School through two programmes: 1) BSc Accounting and Finance and 2) MSc Management.

In summary, the research question of this study is as follows: "in what ways do learners prefer to interact with multimedia microlearning?" Moreover, five research objectives were developed as follows:

(1) To review the key aspects of effective interactive multimedia microlearning.

(2) To design and develop a questionnaire for collecting primary data in order to understand how learners would prefer to interact with multimedia microlearning.

(3) To evaluate the collected primary data from the questionnaire in order to answer the research question.

(4) To inform the design of an interactive multimedia microlearning project.

(5) To widen the knowledge of microlearning practice.

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 videos can facilitate microlearning (Yousef *et al.*, 2014; Delen *et al.*, 2014), previous studies also indicated that the results of using videos on supporting learning would be affected by various factors. For example, Yee *et al.* (2020) found that the engagement declined with the 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) find 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: 1) how the learners prefer to control the multimedia, 2) how the learners prefer to express themselves, 3) what is the preferred level of control in terms of attempting assessments and 4) 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 a promising solution (De Jong and Lazonder, 2005). In fact, the benefits of learner control are many. For example, Miller (1990) suggested learners with control feel more responsible for their own learning process. Lawless and Brown (1997) indicated that learner control enables learners to adapt the learning materials in their own cognitive needs.

Although the benefits of learner control have been studied widely, a lack of related works is found in terms of how learners perceive the usefulness of learner control functions of microlearning videos. Perceived usefulness refers to the degree that how a user believes the use of a particular technology would enhance his/her performance. The understanding of perceived usefulness is important in this study because perceived usefulness affects learning results and learners' adoption in e-learning (Šumak *et al.*, 2011; Liaw and Huang, 2013; Zhang *et al.*, 2017).

Wouters *et al.* (2007) suggested that learner control involves different forms of interaction, including sequencing or selecting the content, or modifying the pace of presentation. The study also indicated the pause button is one of commonly used exemplar functions. Clark and Mayer (2016) summarised that one of the key principles is to always let learners set their pace of learning, such as allowing learners to pause or to set their speed during learning. Moreno and Mayer (2007) provided examples of learner control including: using a pause/play button, forward and back button and slider bar. The correlational relationship between the frequencies of long pauses and experienced difficulty in learning has been found in Li *et al.* (2015). Mayer (2014) suggested that presenting the learning materials in learner-paced segments would improve learning results rather than in a continuous flow.

Moreover, Salamé and Baddeley (1989) found the effects of background music on phonological short-term memory. Taylor *et al.* (2009) proved the significance of the role of voices on mindfulness training. Hallam *et al.* (2002) reported that the calming music led to better performance on tasks. Hooper *et al.* (2007) found that changes of frame rate of learning videos had significant effects on learners' comprehension. Therefore, providing related functions for learners to control visual and audio content are expected to have positive impacts on perceived usefulness.

According to the above discussion, the first hypothesis is proposed as follows:

H1. Control function in microlearning videos is perceived as useful.

In order to evaluate H1, nine functions are listed in this study (i.e. brightness, volume, speed, caption, playback bar, background music, pitch, resolution and play/pause). If H1 is supported, control function should be considered a useful element in microlearning video – its related function should not be considered 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 a tool to drive peer engagement with users (Harris and Dennis, 2011). Jensen Schau and Gilly (2003) suggested that "likes" represent self-expressive behaviour, which is consistent with the personal element of users' engagement behaviour. Moreover, it manifests 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 is expected to have a positive impact on perceived usefulness. Therefore, according to the above discussion, the hypothesis is proposed as follows:

H2. Expression function in microlearning video is perceived as useful.

In order to evaluate the H2, four expression functions are suggested in this study (i.e. like, dislike, subscribe and comment). Similar to H1, if H2 is supported, expression function should be considered 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, namely 1) multiple choice questions and 2) open-ended questions are commonly used in practice. Therefore, two new hypotheses are proposed as follows:

H3. Learners prefer to have more control in the arrangement on their multiple-choice questions.

H4. Learners prefer to have more control in the arrangement on their open-ended questions.

In addition, a further hypothesis is proposed as follows:

H5. 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 were 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 the Business School through two full time programmes: a) BSc Accounting and Finance and b) MSc Management. The sample was selected because they were the groups

which the researchers were able to connect with during teaching. This study can be extended to learners from different backgrounds in future study.

3.2 Data collection method

A self-developed questionnaire was used in this study for data collection purposes. The questions were developed from the material discussed in the literature review: this includes in section 1, questions related to control function were supported by Wouters *et al.* (2007) in section 2 and 3, questions related to preferred level of control were supported by Kostons *et al.* (2010) and in section 4, the question about time to attempt assessment was supported by Walker (2007), and questions related to perceived usefulness of expression were supported by Hoffman and Fodor (2010). A pilot questionnaire was developed to collect feedback from the corresponding colleague and selected student representatives about the questionnaire. The purpose of the pilot questionnaire is to evaluate how potential participants may understand the questionnaire and whether potential participants may feel pressure to answer the questions. The pilot questionnaire has also been used to evaluate whether potential participants interpret the questions as per the design purpose.

This research took place online and Microsoft Forms (MS Forms) was used as the platform of the questionnaire.

In order to recruit participants, all learners who were enrolled into the relevant three modules were contacted directly by the researchers through the learners' email. More specifically, the email contains the web link of the questionnaire. The data collected from MS Forms were exported to Microsoft Excel and then to SPSS for further analysis purposes.

This study was conducted in compliance with the University's (the researcher's employer) Code of Practice on Research Ethics and Governance. Before the fieldwork started, formal Ethical Approval for this research study had been obtained on 5th February 2021 from the Faculty's Ethics Committee of the University where data are collected.

3.3 Design of the questionnaire

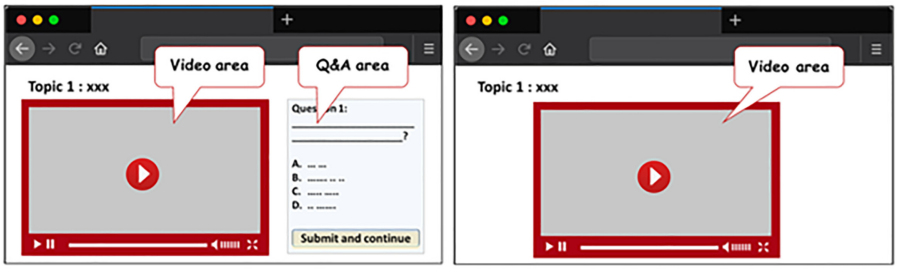
The questions in the questionnaire were self-developed according to the identified aspects discussed in the literature review as explained in Section 3.2. A sample of the questionnaire can be found in Appendix 1. As mentioned earlier, the pilot test on the questionnaire had been conducted to ensure the validity. We used closed-ended questions as the main body of the questionnaire. In addition, 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.

In terms of the structure, the questionnaire consists of two major parts. The first part is a participant information and consent form. The second part of the questionnaire has five sections as follows.

In section 1, participants are required to rate the usefulness of nine control functions (brightness, volume, speed, caption, playback bar, background music, pitch, resolution and play/pause) as per H1. The section starts with a short background statement which assumes participants are learning with a 5–10 min educational video, and then the participants are required to rate nine five-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 a control function according to H1. The hypothesis proposes that control functions in multimedia microlearning are perceived as useful.

As per Figure 1, section 2 starts with a scenario which assumes participants are learning with a 5–10 min educational video which contains a multiple choice question. The participants can also find two different multiple choice 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 H3. In addition, participants have also been invited to

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	Design B
This design has two areas, video area and Q&A area. The multiple choice question is arranged as follows:	This design has one area, the video area. The multiple choice question is arranged as follows:
1) You are watching the video	1) You are watching the video
2) The video pauses and the question appears on the Q&A area.	2) The question is asked inside the video
3)You are required to choose the answer, then click the "submit and continue" button.	3) After a few seconds of waiting
4) The answer and explanation are provided in the Q&A area	4) The answer is provided and explained in the video.
5) The video continues with remaining content.	5) The video continues with remaining content.

Figure 1.
Section 2 of the questionnaire

explain why they prefer the design. This open-ended explanation is an optional question, aiming to gather further qualitative insights from the participants.

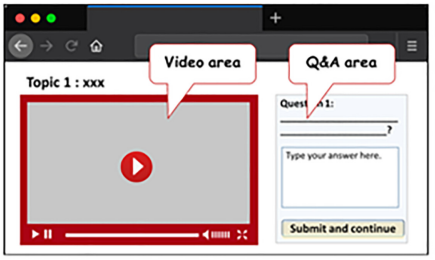
As per Figure 2, the layout of section 3 is similar to section 2. In section 3, participants are introduced with a scenario which assumes they are learning with a 5–10 min educational video, and the video contains an open-ended question. The participants can also find two different open-ended question 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 H4. 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.

Section 4 consists of two sets of questions. The first set of questions provides a scenario to participants that when they are given a 5–10 min 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: 1) questions to be asked at the end of the video and 2) 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 H5.

Moreover, in the second set of question in 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 five-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 H2. The hypothesis proposes that expression functions in multimedia microlearning are perceived as useful.

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

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 open ended 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.

Figure 2.
Section 3 of the questionnaire

3.4 Data analysis and corresponding tools

In this research, median is used, instead of mean, to measure the central tendency of the findings of the sample. In comparison, mean is more suitable for measuring central tendency of continuous data while median should be used when categorical data are ranked in order. For example, in this research, the ratings of control or expression functions are ranked from lowest rating "not useful at all" to highest rating "extremely useful". Therefore, median is used instead of mean in this study. Furthermore, mode is used to report the measure that appears most often in the sample.

In order to conclude whether the findings from the sample related to hypotheses are statistically significant, chi-square is used in this study, instead of other techniques because chi-square test is a nonparametric test that compare the observed data distribution with expected data distribution (Rana and Singhal, 2015). Nonparametric tests are referred to as distribution-free test, which do not require normal distribution of data. Nonparametric test is more suitable; the reason is normal distribution of data should not be expected because Likert data were used in this study. As per Boone and Boone (2012), Likert data express a "greater than" relationship but how much greater cannot be implied; therefore, normal distribution will not be happen, and chi-square test should be adopted

4. Data presentation, analysis and findings

This section reports the findings based on an online survey by means of online questionnaire conducted from 18 February to 4 March 2021 (2 weeks). The findings aim to evaluate the five proposed hypotheses (H1–H5).

4.1 Demographic characteristics of the population and the participants

In total, the invitation had been sent to all 236 enrolled learners from the 3 targeted modules through emails. A total of 77 participants completed the survey with the response rate 32.6%.

Among the 77 participants, there are 43 postgraduates (56%) and 34 undergraduates (44%). In addition, the participants consist of 41 male participants (53%) and 36 female participants (47%). Moreover, the distribution of the age groups is aged 17–21 (23 participants, 30%), 22–26 (30 participants, 39%), 27–35 (19 participants, 25%) and 36–60 (5 participants, 6%). The age range starts at 17 because there are international students who start their study at 17.

4.2 Descriptive analysis of the preferred interaction among the participants

(1) The perceived usefulness of control functions in multimedia microlearning (H1)

The rating results from the 77 participants on the nine multimedia control functions are shown in the bar charts as per Figure 3. These ratings reflect the perceived usefulness of these functions. Table 1 summarises the medians and modes of the corresponding control functions. 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

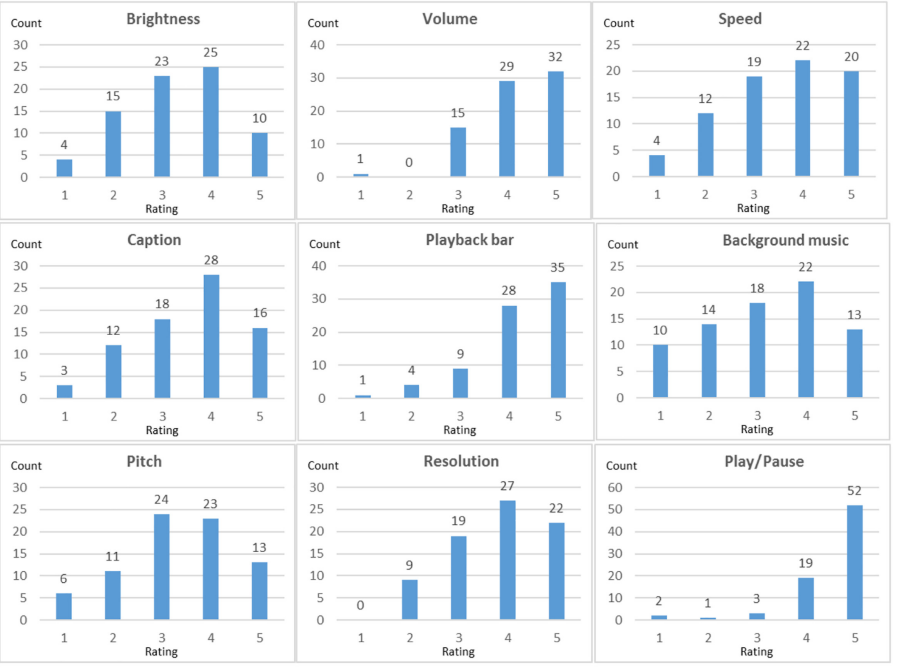


Figure 3.
The counts and ratings of the nine multimedia control functions of participants

Note(s): Rating at 1 represents not useful at all; rating at 5 represents extremely useful

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

	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

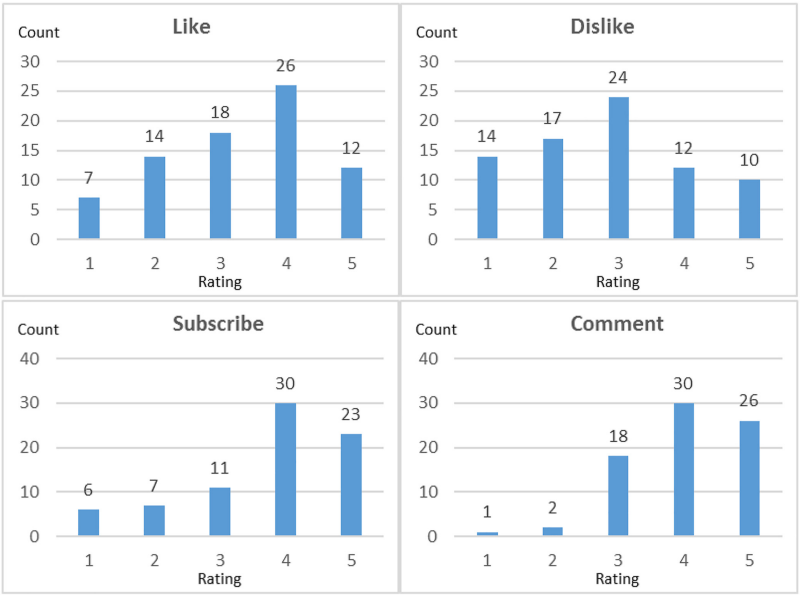
useful). Overall, the results indicate the perceived usefulness of the control functions in multimedia microlearning is generally high.

(2) The perceived usefulness of expression functions in multimedia microlearning (H2)

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.

(3) The preferred level of control in terms of attempting multiple-choice and open-ended questions' arrangement (H3 and H4)

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).



Note(s): Rating at 1 represents not useful at all; rating at 5 represents extremely useful

Figure 4.
The counts and ratings of perceived usefulness of the four expression functions of participants

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

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

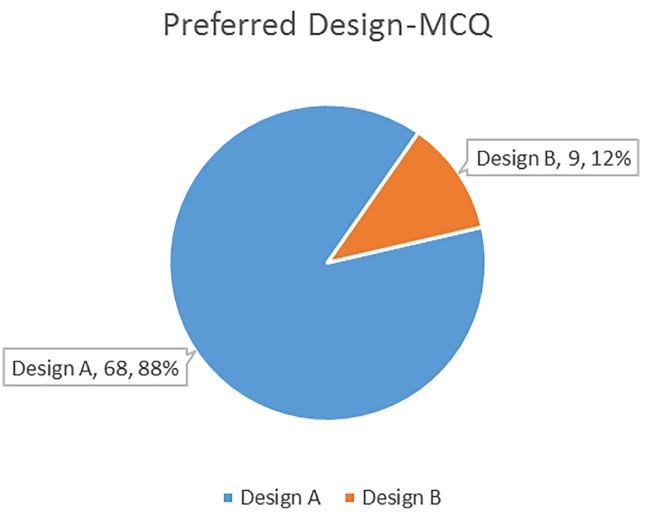


Figure 5.
Preference of design in relation to multi-choice question arrangement

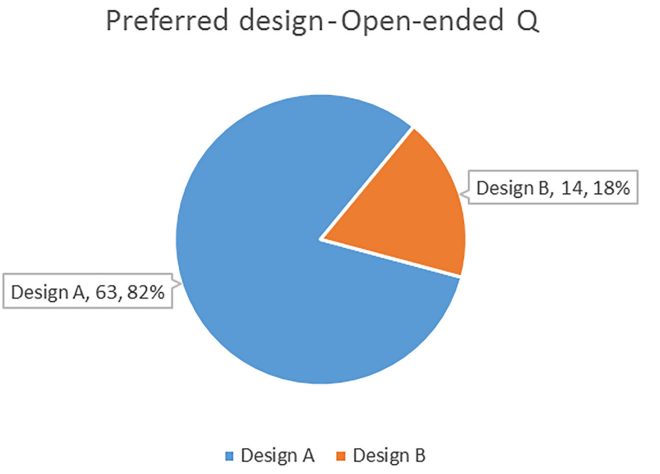


Figure 6.
Preference of design in relation to open-ended question arrangement

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

For the participants selected Design A, easy-to-use, sense of control and encourage participation are general thoughts. Some relevant example comments include "*Option A allows you to critically evaluate your understanding of the video content. Personally I have 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*" "*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*" "*So you do not have to struggle looking at the screen as well as the questions on the side*", etc.

(4) The preference of when to attempt assessment (H5)

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%).

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.

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

The findings reported in the previous section indicate that control functions 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.

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.

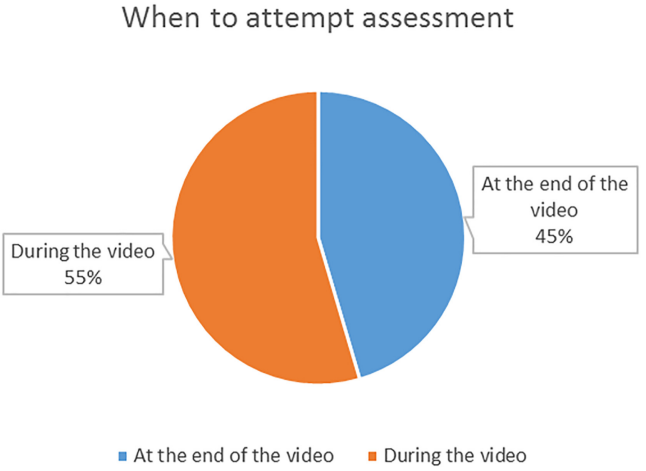


Figure 7.
The preference of when to attempt assessment

(2) 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.

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.

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

Results reported in the previous section indicate 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.

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

Table 3.
Summary of hypothesis 1 testing using chi-square test on the usefulness of the nine multimedia control functions

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

Note(s): The category occurs with equal probabilities. Test: one-sample chi square test. The significance level is 0.05

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

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

Note(s): The category occurs with equal probabilities. Test: One-sample chi square test. The significance level is 0.1

Result reported in the 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.

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.

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

Results reported in the previous section indicate 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.

Although the previous study (Kelley *et al.*, 2015) indicated that time is a key variable in learning related studies, the significant test for Hypothesis 5 found that there was no evidence to show learners have preferred time to attempt session assessment when they attend sessions. This is possible because microlearning involves short learning duration time; therefore, when to attempt the assessments was not a concern for learners.

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

Null hypothesis	Sig.
The categories of design – MCQ (Multiple Choice Questions) 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

Null hypothesis	Sig
The categories of design – open-ended questions occur with equal probabilities	0.000

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

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

5. Discussion

Technology has significantly changed learners' experiences (Sung *et al.*, 2020; Leong and 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.

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.

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

Table 8.
Summary of hypotheses and findings

Hypothesis	What have been tested	Findings	Significance test results
1	The perceived usefulness of control functions in multimedia microlearning	The perceived usefulness of the control functions are generally high	Support the hypothesis
2	The perceived usefulness of expression functions in multimedia microlearning	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 9.
Summary of 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 how learners prefer to interact with multimedia microlearning	In section 3, data collection and analysis methods and tools were compared and 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

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.

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

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

(1) Likert-type items

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

(2) Longitudinal effects

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

(3) Depending on quantitative findings

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

5.1 Recommendations for future research

Other than the above mentioned implications, the findings raised by this current research also indicate several suggestions for future research.

First, cross-disciplinary research could be conducted in order to provide new insights from different perspectives on how learners interact with multimedia microlearning interface design, for example, applications of electroencephalogram (EEG) and eye tracking. These technologies have widely been used in psychology studies in recent years. On this, conducting further research together with experts from other disciplines can help to generate new knowledge on multimedia microlearning video design.

Second, this study was conducted in the United Kingdom (UK); the current study can be extended to learners from different backgrounds, such as from different countries and different socio-economic backgrounds in order to critically compare and contrast the findings. The comparisons can inform how to implement multimedia microlearning effectively in different cultures and for different socio-economic backgrounds.

Hopefully, this study could shed some lights on future research in the field of microlearning and work-based learning.

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Appendix
Sample of the questionnaire

Section 1 of 5

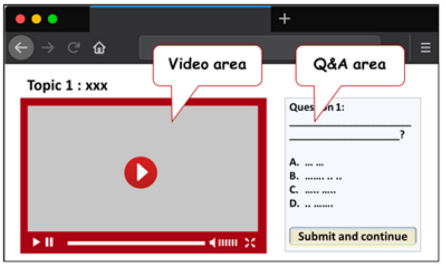
Q1. Assume there is a 5-10 minute educational video. How would you rate the usefulness on the functions listed below?

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)	○	○	○	○	○
Volume (You can adjust the volume of sound – loud to quiet to mute)	○	○	○	○	○
Speed (You can control the video to play faster or slower)	○	○	○	○	○
Caption (You are able to control whether or not to display the caption on screen, which is the transcript of the video)	○	○	○	○	○
Playback bar (You can go to different point in the video)	○	○	○	○	○
Background music (You can adjust whether or not to play the background music)	○	○	○	○	○
Pitch (You can adjust the pitch of sound – high pitch to low pitch.)	○	○	○	○	○
Resolution (You are able to adjust the sharpness or the video or quality of the video.)	○	○	○	○	○
Play/pause (you can play and pause the video)	○	○	○	○	○

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:

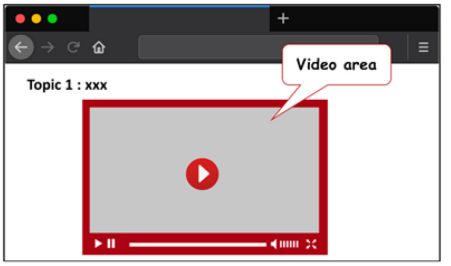
1) You are watching the video

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.

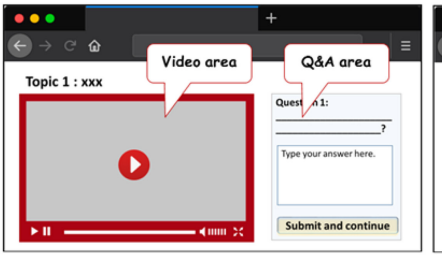
Q3. Which one of the designs would you prefer for multiple choice questions?

- 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:

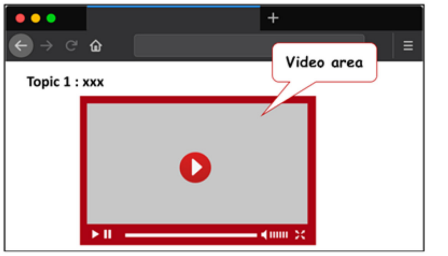
1) You are watching the video

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	○	○	○	○	○
Dislike - this function enables you to dislike the video	○	○	○	○	○
Subscribe - this function enables you to get notice on any new published videos of the course / module	○	○	○	○	○
Comment - this function enables you to leave your comment	○	○	○	○	○

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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