Responsive or Adaptive Educational Mobile Websites: The Impact of Different Designs on Students' Preferences at Jouf University – Saudi Arabia

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ABSTRACT
The current research aimed to develop & compare between two different learning mobile websites designs, which are responsive versus adaptive. The best design amongst them is determined in terms of learners' preferences. To conduct this, the researcher formulated a preference level test (PLT) and installed it on both websites. 84 undergraduate students participated in the main experiment. They were divided into two experimental groups; each group consisted of 42 students. The first group used the responsive website (RW), while the second group used the adaptive website (AW). The results showed the superiority of the second group in the PLT with a statistically significant difference. The research recommended the necessity of raising awareness about the importance of mobile learning, as well as the adoption of effective designs, which enhancing the students' level of preference.

KEYWORDS: responsive design, adaptive design, mobile websites and preferences level.

INTRODUCTION
The rapidly wide usage of mobile in browsing the websites led to make a problem in the design of these sites, and its suitability to different mobile screens in terms of size and resolution (Cazañas, & Parra, 2017). The fixed design became inappropriate method to develop websites, which displayable on different mobile devices (Lestari, Hardianto, & Hidayanto, 2014). Hence the need emerged to adopt other methods for designing websites capable of reformulating themselves to suit the multifarious features of diverse mobile devices (Baturay, & Birtane, 2013). AW or RW is the best solution, because it is convenient to the different mobile devices and guarantee the display of full page without the loss or hiding parts of it. The transformation towards RW or AW has become inevitable to design suitable websites displaying information in a way that suit diverse mobile devices, but in this context, which will be better and more suitable for all variables such as users' expertise, features of devices, cost, usability and navigation type? (Krbecek, & Schauer, 2016). Despite the development of mobile websites developing field, still there are challenges related to the webpage's flexibility, therefore a balance must be achieved between design and use either on the technical or artistic level to reach the most appropriate design that satisfy the learner and leads him to higher level of preference (Groth, & Haslwanter, 2015).

Practitioner Notes

What is already known about this topic
- Millions of learners can access the internet using diverse smart mobile devices.
- The diverse mobile phones and their features pose the greatest challenge in designing sufficiently suitable learning websites.
- The RW and AW represent the best solutions to build suitable learning websites for all types of devices.

What this paper adds
Determining the best design (RW or AW) based on the students' level of preference.
Implications for practice and/or policy

determining the best way to design learning websites that are effective and appropriate for various mobile devices characteristics. determining the basics of designing learning mobile websites that can be accepted and preferred by students.

LITERATURE REVIEW

The RW concept emerged in 2010 by "Ethan Marcotte". Since then it has been used to create several sites (Marcotte, 2011). It was widely used under several names sharing the basic features that characterize it such as "fluid, liquid and flexible design" (Frain, 2012). The RW is characterized by its dynamics as it enables resizing and rearranging the content of the page to suit the available display proportion, as well as the screen size (Hussain, & Mkpojiogu, 2015). Automatic adjustment of web pages is conducted by two features of the RW; namely "flexible grid layouts" and "flexible images and media" (Peng, & Zhou, 2015; Peterson, 2014). So, there is no need to create several separate designs, but only one responsive design can operate on the different devices, by using "HTML5, & CSS3 script language" (Carver, 2014).

In procedural terms, the researcher defines RW as "the designing technique of web pages in a flexible manner, to adjust the display dimensions of the web page and its contents to the device screen dimensions and its resolution, in order to enable a full view of the page". In the learning context, RW enables learners to optimize their performance, without the web developers having exert more effort in creating convenient sites for each device (Tabor, 2016). RW also allows accessing important information easily, rapidly and at lesser effort and cost possible (Bernacki, Błażejczyk, Indyka-Piasecka, Kopel, Kukla, & Trawiński, 2016). Furthermore, there are several advantages of RW, it represents a more appropriated mobile learning environment as it is more readable, enjoyable and useable (Lajis, & Rahim, 2015). RW doesn't distract learner by unnecessary navigation and create high-quality and easily uploaded presentations versus flash-based content presentations (Baturay & Birtane, 2013).

Despite previous advantages, RW is not suitable for building all websites and it requires more improvements by researchers (Peng & Zhou, 2015). One of disadvantages of RW that many mobile devices are not compatible with CSS3 media queries and take more time in the side of image resizing (Rekhi, 2013). The results of a research conducted by Lestari, Hardianto & Hidayanto (2014) indicated that the RW wasn't useful in the aspect of information structure and navigation. The length of navigation menus is a one of navigation problems in the RW (Kumar & Jenamani, 2017). So, exploring the RW navigation menus by mobile devices require searching to see the hidden section of the menu leading to more waste of time, and less usability (Mahajan, Abolhassani, McMinn & Halfond, 2018).

The goal arises in this context is developing learning mobile websites that satisfy learners and grab their attentions (Almaiah, Jalil, & Man, 2016). To achieve this goal, web developers must begin at the principle stating that, the learner really cares for while using mobile websites in accessing all the required information with the least effort and as fast as possible (Sarrab, Al Shibli, & Badursha, 2016). Though the current trend is moving towards RW, there are still paradoxical impressions about the factors related to optimizing its usage, so the researchers are urged to find the best RW design or thinking of another design style such as the AW to reach the level of acceptance, satisfaction and optimal usage (Groth & Haslwanter, 2015).

AW is another method of building mobile website (Harris, 2015). The AW was first introduced by the web designer "Aron Gustafson" as "progressive enhancement of a website" (Soegaard, 2018). In the AW, the java script is used to determine the characteristics of the receiver device, then upload the appropriate template of the website (Burk, 2013). Thus, the AW is concerned with predefine the characteristics of the devices to be taken into consideration while developing the site (Gustfson, 2015). Accordingly, the AW contributes to reducing the unnecessary navigation processes compared to the responsive design, since the site is based on a unique design for each device, so six layouts have been developed for the most common six types of screens: 320, 480, 760, 960, 1200 and 1600 pixels (Cazañas, & Parra, 2017; Soegaard, 2018).

In procedural terms, the researcher defines the AW as "the designing technique according to which several different versions of sites are built to suit each mobile device characteristics, which enable users to interact with their diverse devices". Although both AW and RW are based on the same principal, yet AW is characterized by additions that works on progressive enhancement with the aim of building specialized experience for each device (Gustafson, 2011; Harris, 2015). The AW is similar the RW in that it operates with the users by a single link to all its templates (Gonzalez-Cepero, 2017). Meanwhile, the AW differs from the RW in that it doesn't operate through enhancing the layout only, it employs the "Java Script" to add several functions and features based on the device and the browser capabilities as well as the screen resolution, where high resolution images are provided to the devices that are characterized by their high resolution and vice versa (Burk, 2013).

The AW production depends on single base markup (HTML) to all devices, which means the ability to use the basic code within each layout, the developers no need to draw board and re-codes the existing website from scratch (Pratap, 2013; Charlton 2014). Also, the AW is characterized by its ability to let each device receive what suits its capabilities only, which positively affects the performance & speed of the website (Harper, 2017). In addition, the AW allows a wide class of users to interact through the website, regardless of the internet speed they have by supply of small size templates to be easily uploaded (Bawab, 2017; Tech, 2016).

Bawab (2017), Gonzalez-Cepero (2017), Lang (2018), and Schwarz (2016) highlighted the differences between AW & RW. The first employs the Java Script to determine the device used in browsing and accordingly determine the suitable template for the device features. The other; meanwhile, employs CSS media queries to build flexible layouts for the website that can be resized based on the screen size of the device used. Whereas the RW attempts to deliver the same content to different devices browsing the same website, the AW seeks to deliver a partially different content for each device browsing the same website. Furthermore, the maintenance cost for the AW is higher than the RW because in AW there are more than one template per website need to be maintained. The RW have the lowest performance because it delivers the same content to all different devices, but The AW ranges between medium and high performance based on the construction technique it employs. In terms of navigation, the RW depends on building a single navigation structure for all devices, but the AW employs different navigation designs.

Based on the aforementioned information, the RW is characterized by lesser costs, but it is lower in performance in contrast of the AW (Alexanian,2013; Faletski, 2013). In the learning context, can AW be chosen regardless of the cost? Or can the low performance of the RW be ignored in favour of the low cost especially with the increasing number of online learners using smart phones? (Schmitz, 2014; Cazañas, & Parra, 2017). Or is there another standard to be checked in order to choose the better design; such as the students' preference? In this paper the researcher attempts to answer this question.

The preference level is one of the most significant standards that can be used to judge the learner's motives while interacting with the websites (Bonk, Lee, Kou, Xu, & Sheu, 2015). However, there are many considerations that can affect on the learners' preference level while using the learning websites; such as the template they used to deal with the menus locations as well as the distribution of content and the navigation styles, for example it would be better to navigate websites by horizontal swiping instead of the scroll down and click on buttons (Hasan, 2014; Dou, & Sundar, 2016; Punchoojit, & Hongwarittorrn, 2017). With the increasing number of the different mobile devices used to access the internet, it has become difficult to construct a learning website that suit all the considerations, which increase the importance of determining the elements that would lead to high satisfaction and preference in a way that would help in constructing learning websites capable of motivating the learners to engage in the learning process (Martín-Rodríguez, Fernández-Molina, Montero-Alonso, & González-Gómez, 2015; Mirriahi, & Alonzo, 2015).

There are several indicators revealing the users' preference to the learning websites, among these is the average click ratio, which mean the higher the average click ratio is, the lower the user's preference is, because its increase signifies the learner's confusion within the content and drifting off the right track to complete the targeted assignment while wasting more time in meaningless navigation processes (Kumar, & Jenamani, 2017). Another indicator of the user's preference is the time consumed to navigate the website,

and its relationship with the achievement criterion, if it was positive, it indicates a higher level of user's preference (Chen, 2018; Pan, 2015; Yu, & Kong, 2016). Moreover, enjoying the website is another significant indicator revealing the user's preference, whereas the frequency of accessing the website and the time learners spend interacting on their content without having tasks to accomplish indicates their desire to enjoy it (Groth, & Haslwanter, 2015).

In procedural terms, the researcher defines the preference level as: "the significant indicators revealing the learners' easy access to the learning website browsed through a mobile phone and their interest in it, which are determined by the number of tasks accomplished through the website, the total time consumed, the web pages browsed to accomplish these tasks, the scrolling and clicking rate as well as the frequency of accessing and the time spent in interacting without having tasks".

Garett, Chiu, Zhang & Young (2016) determined seven pivotal design elements impacting the learners' preference of learning websites, which are navigation, graphical representation, organization, content utility, purpose, simplicity and readability. Furthermore Clay (2018) has given recommendations in designing navigation structure of learning mobile websites such as; maintaining short & catchy navigation links, placing the most important links on top of the navigation menus, finding logical navigation tracks, paying attention to the font style and diversity of design and ensuring that the design is compatible with touch screens with diverse features. As well Muniasamy, Ejalani, & Anandhavalli (2014) recommended taking into consideration the learners' preference when designing e-learning tools, because its study result concluded that although Saudi universities have provided several e-learning tools via mobile, learners neither share nor use those tools efficiently, which might be due to their rejection or not preferring those tools as they are not well designed. Furthermore, another study conducted by Batra (2017) referred to the importance of finding new designs that can be compatible with diverse mobile phones, which should provide learners with compatible websites and protects the learners from wasting more time and efforts to reach the targeted information.

Based on the results above, there is a need to define the most preferred design of learning mobile websites from the most compatible designs for diverse mobile phones; either AW or RW, to be generalized in developing different learning websites at Jouf University.

METHODOLOGY

the quasi-experimental methodology was followed; two experimental groups with no control group design, to examine the following research hypothesis: "there is no significant difference between the average scores of the RW group and the AW group at the preference level test".

Participants

The research community were (386) students, who enrolled in the course "university life skills" during the academic year 2018/2019. The participants chosen are those who have online connected smart phones. To make sure they are equivalent in the skills of using smart phones, they were assigned a learning activity via the "Blackboard application". The participants who accomplished their tasks through the mobile correctly were (104) students. Twenty students were chosen to the pilot experiment and (84) students were chosen to the main experiment. They were distributed among the two experimental groups. Each group comprised (42) students.

Procedures

First, constructing and hosting the learning RW and AW. To create the RW, "HTML, CSS3" was used whereas "HTML, JavaScript" was used to create the AW. The pages and the navigation structures of the two produced websites are cleared by the following figure:

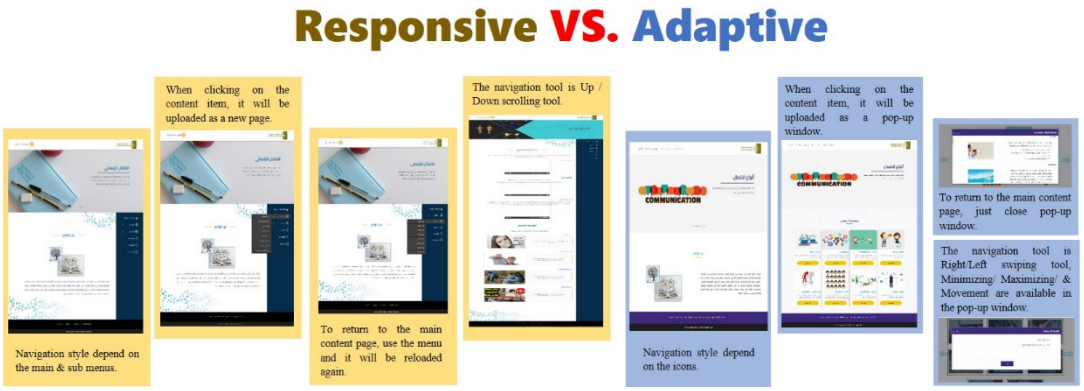

Figure 1: the difference between the RW & AW.

Secondly, building the PLT. This test aims at measuring the learners' preference level while using the produced websites. In order to achieve this, several research papers that are relevant to the preference level are reviewed such as (Groth, & Haslwanter, 2016; Lee, & Koubek, 2010; Lestari, Hardianto, & Hidayanto, 2014). In this context, the researcher suggested the preference indicators and its verification tasks, then it is previewed by five specialists on educational technology. After that the agreed amendments was carried out and a final list of preference indicators and its verification tasks are reached.

The final preference indicators determined in the time, number of browsed pages, clicks rate, scrolling & dragging rate used to accomplish each task as well as the frequency of accessing without having tasks "free accessing" and the total time spent without having tasks to accomplish. The two produced websites programed to automatically calculate these indicators and record it in the control page.

To estimate the scores of the PLT, researcher had to change the raw scores recorded after each task into marks by transforming them to standardized scores (z_{PL}), where the average ($\bar{x}$) and the standard deviation (σ_x) are known and by applying the equation ($z_{PL} = x - \bar{x}/\sigma_x$). This method was applied to several previous researches to compare the scores with different nature and measurement (Kapri, 2017; Kranzler, Floyd, Benson, Zaboski, & Thibodaux, 2016; Miciak, Fletcher, & Stuebing, 2016; Taylor, Miciak, Fletcher, & Francis, 2017). The standard scores refer to the increase or decrease of preference level through estimating the rate of deviation for the learners' raw scores for all the tasks away from the average. Positive deviation from the average indicates an increase in the mark which in turn indicates a decrease in the preference level in the first four indicators. Meanwhile, it indicates an increase in the preference level within the fifth and sixth indicators. In order to tackle the standard scores easily, they are transformed to "T-scores" through the equation (T-score = ($z_{PL} * 10$) + 50).

After completing both websites with PLT, the specialists had reviewed them, then the agreed-on amendments had been done, and then the pilot experimentation was carried out for both websites. The results of the pilot experiment indicated that both websites operate efficiently, and the PLT had acceptable validity and reliability, as shown in the following tables:

Table 1: differentiation validity for the PLT-N=20

PLT Indicators	*The average for the higher and lower values for the PLT indicators*	*The Standard Deviation for the higher &lower values of the PLT indicators*	*The Difference between both Averages*	*The value of (T)*	*Significance*
Accomplishment Time	434.60	8.99	79.00	11.42	.000
	355.60	12.58			
Number of Pages	45.80	2.61	10.20	8.06	.000
	35.60	1.10			
Click Rate	110.80	2.28	13.00	9.24	.000
	97.80	2.17			
Scroll and Dragging Rate	147.00	9.02	29.40	5.15	.001
	117.60	9.03			
The Frequency of Free Accessing	4.20	.55	2.60	8.22	.000
	1.60	.45			
Total Time Spent in Free Interaction	315.60	5.32	113.20	5.21	.001
	202.40	48.27			

The previous table indicates that, the T- value for all indicators shows a significant difference between the highest quarterly and the lowest quarterly. This proves the differentiation validity for the PLT.

Table 2: The reliability of the PLT-N=20

Pairing Factors	*Paired Samples Correlations*	*Correlations Sig.*	*Paired Samples T-Test*	*T-test Significance*
Total marks of the accomplishment time (test and retest)	.89	.000	.76	.459
Total marks of the number of pages (test and retest)	.77	.000	.08	.935
Total marks of the click rate (test and retest)	.79	.000	.35	.732
Total marks of the scroll and dragging (test and retest)	.74	.000	.61	.546
Total marks of the frequency of free accessing (test and retest)	.87	.000	.44	.666
Total marks of the time spent in free interaction (test and retest)	.89	.000	1.12	.278

The previous table indicates that the values of paired samples correlations ranged between (0.74, 0.89). All the values of the paired samples T-Test were insignificant. This proves the reliability of the PLT.

Thirdly, beginning the main experiment by meeting the participants in both experimental groups, each group on its own, to inform them with the the required instructions and objectives of the experiment. The experiment lasted for eight weeks from 16/9/2018 to 8/11/2018. The experiment took place from two to

three sessions per week (an hour per session) for each experimental group, each on its own in the classroom at the college. Having completed the assigned tasks, the websites became available for recording the frequency of free accessing and the time spent in free interaction by participants. By the end of the eighth week of the main experiment, the recorded raw scores on the control page were retrieved. They are then processed and converted to their final form to be ready for statistical processing.

RESULTS

Having completed the procedures of the main experiment and recorded the learners' scores in the PLT, the researcher used the 21st program edition of Statistical Packages for Social Sciences (SPSS) for statistical processing. To validate the authenticity of the research hypothesis, the difference between the participants' average T - scores in the post measurement for the PLT was calculated by using "Independent Samples T-test". The effect size (η2) was calculated to recognize the experimental effect size for the contrast rate between RW and AW within the preference level. The values of the effect size range from zero to one. Cohen's criteria (Cohen,1988) was used to evaluate the value of the effect size, which determined in the following "the effect size (0.01) of total contrast indicates a low effect, the effect size (0.06) of total contrast indicates a medium effect and the effect size (0.15) indicates a large effect". The following table shows the research results:

Table 3: The Independent Samples T- test Scores for the differences between the two Experimental Groups' T- Scores averages in the PLT Post measurement

PLT Indicators	*The First Experimental Group (42)*		*The Second Experimental Group (42)*		*Arithmetic "T"*		*Effect Size (η2)*	
	Arithmetic Average	*Standard Deviation*	*Arithmetic Average*	*Standard Deviation*	*Value*	*Significance*	*Value*	*Significance*
Accomplishment Time	59.64	2.07	40.36	2.78	36.05	.000	0.94	Large Effect
Number of Pages	59.77	2.09	40.23	1.57	48.52	.000	0.96	Large Effect
Clicks Rate	59.51	3.12	40.49	2.71	29.83	.000	0.91	Large Effect
Scrolling and dragging rate.	59.69	2.49	40.31	2.00	39.28	.000	0.95	Large Effect
Frequency of free accessing.	40.61	1.95	59.39	4.26	25.96	.000	0.89	Large Effect
Total time spent in free interaction	41.11	5.29	58.89	3.55	18.09	.000	0.79	Large Effect
Total test score	320.33	9.58	279.66	11.15	17.93	.000	0.79	Large Effect

The value of table "T" at free degree (83) and a significance level of (0.05) =1.99
The value of table "T" at free degree (83) and a significance level of (0.01) = 2.64

It is clear from the previous table the existence of the statistically significant differences between the average t-scores of the two experimental groups in the PLT post measurement, in favor of the second experimental group. The first four indicators (accomplishment time, number of pages, clicks rate and scrolling and dragging rate) were lower than the average T- scores of the first group in the same indicators, which mean the students of the second experimental group spent less time, browsed fewer pages, and did lower clicks, scrolling, and dragging rates to accomplish the assigned tasks compared to the first experimental group. This may reflect the superiority of the AW in terms of organizing the content and the smooth navigation system, which supported the learners in accomplishing the tasks quickly and easily compared to the RW. Meanwhile, when it comes to the indicators reflecting the interest in the site and the students' satisfaction with the technical and aesthetic efficiency of the site, the fifth and sixth test indicators (the number of free accessing and the total time spent in the free interaction) the average T -scores of the second group were higher than the average T- scores for the first group. This indicates the superiority of the AW over the RW in this area. Generally, the total test scores indicate the increase of preference level for AW compared to the RW. Hence the thesis hypothesis is rejected. The large size effects for the preference level for AW varied from (0.79 to 0.96). This indicates the efficiency of AW design in the learners' preference increasing for learning through mobile phones.

DISCUSSION

The current research results are attributed to the fact that the AW is characterized by more variable features compared with the responsive design. It is characterized by an easily accessible navigation style that enabled learners to access any part of the content just by clicking the icon representing the targeted section of the content. Major sections of the content are designed in the form of icons. When any of them is pressed, the page is loaded in the form of a pop up window. The learner can navigate within the page by dragging left or right. To go back to the main page, the window is closed and there would not be a need to load the main page once more. This in turn leads to easy access to the required information. The content icons are clarified using texts and visual symbols; each expressing the content it comprises. These in turn enables the learners to easily access and recognize the targeted sections of the content. It reduced the need to browse a larger number of pages, to do a higher rate of scrolls and dragging. Eventually this is translated into easy access to the information required to accomplish the targeted tasks.

Meanwhile, in the RW, the learner needs to do more scrolling and dragging downwards and upwards to review the elements of the pages. For example, when clicking each link, the affiliated page is loaded, and to go back to the main page, the learner has to click the main page link from the main menu to reload it once more; which takes more time especially if the internet speed is limited. This navigation style leads to a higher rate of clicks and scrolling and wasting more time to accomplish the targeted tasks.

The previous results contend with what previous research indicated (Bawab, 2017; Gonzalez-Cepero, 2017; Harper, 2017; Lang, 2018) concerning what distinguishes AW over the RW in terms of the nature of the adaptive design, which designed specially to suit the capabilities and features of smart mobile phones. This feature does not exist in the responsive design, which is originally constructed for personal computers with technology makes it capable of responding to any device. Yet with the consistency of the design in all the devices and stability of the navigation structure, the design cannot simulate the potential of each device or individually change the content displayed based on the speed of the Internet available to each user whether by the display of some elements and parts of the content or not. Meanwhile the adaptive is capable of all that. It can also consider the characteristics of the browser used to access the website to give the highest performance possible.

The AW excellence is also due to the students' satisfaction with the technical and aesthetic efficiency of the design because the AW is characterized by the good content organization, so that the learner feels the unity of the subject and can form a comprehensive idea of the website content. The easy use of AW navigating tools led to increased integration of the learners with the website content, which reflected to the frequency of free accessing and the time spent in the free interaction.

CONCLUSION

The current research found a high level of student preference for the use of learning mobile websites designed according to AW technology compared to learning mobile websites designed with RW technology, with a statistically significant difference. This is due to the AW features such as the easy navigation system and the good content organization. Moreover, the design focuses on the elements of the interaction and elements of the main content without distracting attention between the elements and links or other incomplete parts of the content. It is a design specifically framed to work on certain phones and is compatible with their characteristics and their diverse capabilities. This, in turn, led to its superiority over the RW in the aspect of learners' interest and interaction with the website and its components.

The results of the current research as well as previous researches have led to several recommendations. First there is a need to spread awareness about the importance of learning through mobile while depending on effective designs. Second, considering the learners' preference as a one of the significant factors that motivates learners to use mobile technologies in learning effectively, so it has to be given a due attention in further research. The researcher suggests conducting further research to measure the difference between the responsive and adaptive designs in the presence of other variables such as visual thinking, mental capacity, cognitive load and engagement in instruction. The same research can be conducted with the addition of other devices such as tablets, laptops to widen the comparison range and find more differences by applying the experiment to more participants.

Limitations of the study

The current research limited to designing the third chapter entitled "communication skills in university environment" in the course named "university life skills" by Dr. Abdul Majid El Grewy, the major reference to the course. The chapter was presented by developing two learning websites; one employing RW technique whereas the other employs the AW technique. The research tools were applied to a group of the undergraduate students at the Faculty of Science and Arts in Jouf University, Saudi Arabia during the first semester of the academic year (2018).

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Statements on open data, ethics and conflict of interest

Data can be accessed by contacting the author (saved in a personal repository).
Ethical approvals were gained from the hosting institution.
No conflict of interest declared.

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