Received November 4, 2019, accepted December 9, 2019, date of publication December 17, 2019,
date of current version December 26, 2019.

Digital Object Identifier 10.1109/ACCESS.2019.2960270

Misinformation-Aware Social Media: A Software Engineering Perspective

MALIK ALMALIKI
College of Computer Science and Engineering, Taibah University, Yanbu 42353, Saudi Arabia
e-mail: mrmalki@taibahu.edu.sa

ABSTRACT Misinformation is extensively and speedily spreading on social media platforms. This leads to sever negative impact on users of social media and the quality of online created content. Fortunately, there is a growing interest among researchers to fight misinformation on social media by the production of algorithms that can detect low quality information. However, none of these studies focus on how to promote a healthier behaviour among social media users to minimize the act of spreading misinforming. In this paper, the author advocates that gamification can be adopted for the aim of enhancing users' behaviour towards misinformation and increasing their critical digital literacy. An empirical study was conducted to investigate users' perceptions with regards to the use of several gamification elements on social media to combat misinformation spread. The results indicated that users' preferences and perceptions vary and highlights the need for systematic and novel approaches to incorporate gamification into the design process of social media to combat misinformation spread. Based on the results, the author devised a conceptual framework that can serve as a guide for software engineers to design a gamified misinformation-aware social media.

INDEX TERMS Gamification, misinformation, social media, software engineering.

I. INTRODUCTION

Online social media platforms (e.g. WhatsApp, Twitter, Facebook, etc) have become a widely used medium for creating and communicating user generated content. This is due to the fact that they provide users with the ability to share information rapidly and timely in a user-friendly manner. In addition, they can also serve as a fast medium for information exchange during disasters [2], [3] and as a plentiful information pool for knowledge creation and exchange [4]. This has led to making social media platforms a valuable and important source of information [1].

However, a critical challenge that faces social media platforms is that the information generated and exchanged on theses platforms is not always reliable [1]. Misinformation, defined as false or inaccurate information, is broadly and quickly spreading (intentionally or unintentionally) on these social media platforms [5]. This fast spread of online misinformation is seen by The World Economic Forum as one of the present top ten issues that the world needs to focus on [6]. A recent research on misinformation distribution on social media [1] showed that about 67% of users indicated that they contributed in sharing misinformation on social media themselves. In addition, around 94% of users indicated that they witnessed other users distribute misinformation on social media.

Misinformation is found on social media in various types (e.g. urban, rumours, factoids, legends, etc) and share a common feature which is that it is untrue or imprecise information [5]. In addition, misinformation distribution on social media platforms can result in serious negative emotions, misunderstanding and anxiety amongst the users of these platforms [7]. Furthermore, misinformation can lead to online criminal activities that result in serious harm to users [1]. Figure 1 shows the results of a recent study which concluded that one in every ten Americans has suffered mental or emotional stress as a result of untrue information about them distributed online [22]. Moreover, the distribution of misinformation can severely damage the effective and efficient use of information content created on social media [7].

Recently, several studies from computer science and information system explored misinformation spread with the aim to produce algorithms that can detect low quality information [3], [7], [8]. Another study examined the effect of user-intrinsic factors (e.g., personality traits and motivation) and their possible impact on users' behaviour towards spreading

The associate editor coordinating the review of this manuscript and approving it for publication was Michael Lyu.

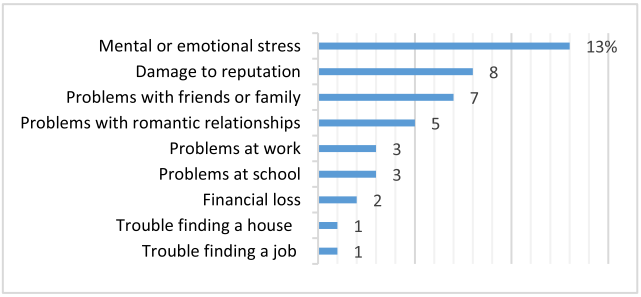

FIGURE 1. Types of misinformation harms experienced by U.S. adults [22].

misinformation on social media [9]. However, none of these studies focus on how to promote a healthier behaviour among social media users to minimize the act of spreading misinforming [21]. Luckily, software as a medium for misinformation spread could also be a mean for passing a user's behaviour change strategy to minimize the act of misinformation distribution on social media platforms. This can ultimately minimize the harmful effect of misinformation on users and improve the quality of information created and exchanged on social media platforms.

Gamification, described as the adoption of game design elements (e.g. points, levels, and achievements) in a non-game context [10], has been used as an effective behaviour change tactic to increase users' motivation and engagement for the purpose of changing their behaviours towards desired ones (e.g. less misinformation spreading) [11]. A common application of gamification is to take the scoring elements of video games, such as points and levels, and apply them to a non-game context (e.g. educational context) [12].

There are several successful applications of gamification to achieve a variety of goals in various environments such as adopting a better and healthier lifestyle [13], [14], enhancing students' engagement with class activities to achieve better results [15], [16], enhancing quality and productivity in a business environment [17], [18], etc. For example, in a business environment, such as call centres, several game elements such as points and achievements, can be adapted to indicate the performance of employees, e.g., the number of calls taken, the number of problems solved, the time taken for finishing a task, and the customers' overall satisfaction [19].

Likewise, Gamification can be incorporated into the design process of social media platforms for the aim of enhancing users' behaviour towards misinformation and increasing their critical digital literacy. For example, a user can gain or lose points on the quality of their news posts based on the ratings given by other users in their social network. This can improve the quality of the generated content on social media by motivating users to share and generate high quality content in a gamified and more enjoyable environment.

However, how can software engineers employ gamification to minimize misinformation spread on social media platforms? What are users' perceptions, likes and dislikes regarding the use of various gamification elements in the context of misinformation spread on social media? There is a research lack on how to systematically use gamification to combat misinformation on social spread media in a way that maintains user's experience and, at the same time, increases the quality of shared online content. An ad hoc design of gamification can have major effects on users and leads to a negative user experience and performance comparing to a non-gamified process [20]. This highlights the need to study and investigate (from a user's perspective) how gamification can systematically be adopted in the context of misinformation on social media platforms.

In this paper, the author empirically investigates the applicability of systematically incorporating gamification elements into the design process of social media to minimize the behaviour of misinformation sharing. That is, users' various needs and preferences regarding the use of gamification elements to fight misinformation spread are investigated. Based on the results, a conceptual framework is devised to guide software engineers on the design of gamified social media applications that are misinformation aware. This will ultimately help improving users' behaviour towards misinformation sharing on social media platforms thus the quality of content created and exchanged on these platforms.

As the data types being posted by users on social media platforms varies (e.g. news, stories, jokes, etc), The author scoped this research to news data being shared or posted on social media platforms by regular users (i.e. excluding users who represents official news sources or agencies on social media). By news we mean information about current or previous events that are related to different topics such as war, government, politics, education, health, the environment, economy, business, fashion, etc. In addition, this study is only concerned with misinformation that are being shared or spread unintentionally by users of social media. This excludes any investigations into intentional spread of false or inaccurate information from the scope of this research (i.e. disinformation).

This paper is structured as follows. Section 2 discusses the research methodology adopted. Section 3 presents and discusses the study's findings and Section 4 introduces the prosed conceptual model for the design of misinformation-aware social media. In Section 5 the study's threats to validity are presented whereas Section 6 concludes the paper.

II. RESEARCH METHODOLOGY

A quantitative study using a questionnaire approach is performed to investigate users' perceptions regarding the adoption of a set of commonly used gamifications elements as motivators to reduce misinformation spread on social media platform. These commonly adopted gamification elements, as identified by [22], are as follows:

- **Points:** Points are the basis of various gamification elements such as levels and leader boards. In this study, users can gain or lose points based on their news pots quality ratings given by other users. Many researchers also concluded that points have to be used in combination with other gamification elements in order to

effectively motivate users [22]. For example, a user who gains more points on the quality of their news posts can eventually be represented in a leader-board to show the progress they made to other users.

- **Digital Badges:** Badges or achievements are representative awards provided to users for completing ''any type of skill, knowledge or achievement'' that can be displayed by users to ''let others know of their mastery or knowledge'' [23] and typically have specifically stated criteria [24]–[26]. For example, users can be given digital badges to indicate that they represent a trustworthy source of news when they manage to collect a predetermined number of points based on the quality ratings of their news posts.
- **Levels:** To implement levels, users must first obtain points. After obtaining a certain predefined) number of points, users level up. Generally, moving a level up refers to some types of in-game benefits (e.g. unlocking more software/game features) [27].
- **Leader boards:** Leader boards can be built based on a points system, on how many achievements a group of users have made, or on a user's progress ratio towards an end goal [25].

A. QUESTIONNAIRE DESIGN

The designed questionnaire contained 18 different types questions (e.g. single choice and multiple-choice questions, matrix questions, etc). First, the questionnaire was tested on five respondents who fit the sampling measures of this study. The responses collected from them were then used for improving and refining the questionnaire before distributing it to a greater sample of respondents. The participants were invited to take part in the study by email and WhatsApp. The invitation presented a brief explanation of the study's aim and a URL to access the questionnaire. To familiarize the participants with the subject matter, a summary to the study's topic was presented at the beginning of the questionnaire itself. The respondents were also briefed about what is expected from them and how their contribution will be used. The data collection stated on May 9 and ended on July 10, 2019. A week after sending the questionnaire, a reminder was sent to the subjects who did not reply to the participation invitation. A copy of the questionnaire submitted to the participants can be found at: https://bit.ly/2zqdWLN.

B. SAMPLING

To select the study's participants, a simple random sampling method was adopted. The use of this sampling method helps to minimize bias in choosing participants and gives more space for the result to be generalizable to bigger population groups [28].

The author was given access to students and staff members contacts details at Taibah University. Then a computer software application was utilized to randomly produce and extract a set of contact lists that were then used as a selected sample. Moreover, to counterbalance the homogeneity of the university participants in terms of their geographic and demographic characteristics, a convenience sampling approach was also adopted to select more respondents (50) from 16 different countries including USA, UK, Franc, Egypt, Germany, Ireland, Spain, Switzerland, India and Netherlands.

A total number of 175 participants were contacted to participate in the study. 145 of them started the survey and 100 fully completed forms were collected. The author considers this number of respondents to be a good level of return taking into consideration the average time taken to complete the survey (15 minutes) and the level of effort required to complete it. The survey was closed once a total of 100 participants was reached.

C. ANALYSIS

The collected questionnaire responses were first prepared and cleaned up for analysis and unrelated or inconsistent responses were discarded (i.e. 45 incomplete and randomly filled forms were omitted). Then a statistical analysis of the responses was carried out to represent the collected responses [29]. This descriptive analysis was done using Qualtrics (www.qualtrics.com) which is widely used online survey software.

The participants' characteristics were analysed and summarized using cross tabulation and frequency sums. The respondents were compared based on their age, gender, nationality and level of education. This analysis demonstrates a high level of diversity among the respondents which can positively impact the generalizability of this study's findings. Table 1 shows the characteristics of the respondents.

III. FINDINGS

The findings of this study are grouped into five main themes that are discussed in more details in the following subsections.

A. GAMIFICATION TO COMBAT ONLINE MISINFORMATION

Before digging deeper to find out how to incorporate Gamification elements into the design of social media platforms to combat the spread of misinformation, the study investigated users' acceptance of this idea in the first place. The participants were explicitly asked whether they think social media platforms should have a feature that allows them to rate the quality of news data being posted by other users (e.g. their online friends). Around 52% of the participants answered with yes and around 39% of them were unsure (see figure 2).

In addition, more than 53% of the participants indicated that the existence of such a feature can make them more cautious about the quality of the news they intend to post and more willing to check the accuracy of the information they share (see figure 3). This gives an indication of the need for novel and appealing methods to enable social media users to take an active role in fighting online misinformation spread (e.g. the use of gamification). This can ultimately lead to

TABLE 1. Participants' demographic information.

		Age Groups					Gender		
		18-25	*26-34*	*35-54*	*55-64*	*Total*	*Male*	*Female*	*Total*
level of education	*High school*	4	1	2	0	7	4	3	7
	Bachelor's degree	21	11	6	2	40	8	32	40
	Master's degree	0	5	7	3	15	7	8	15
	Professional degree	0	0	2	2	4	2	2	4
	Doctorate degree	4	10	14	3	31	22	9	31
	Others	2	1	0	0	3	2	1	3
	Total	31	28	31	10	100	45	55	100

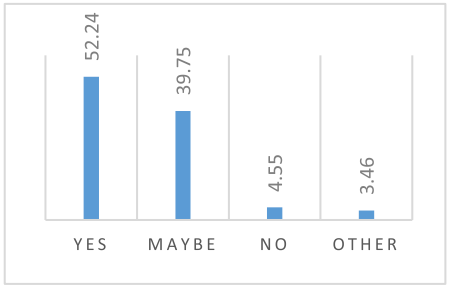

FIGURE 2. Users' acceptance of a rating feature for the quality of social media news posts.

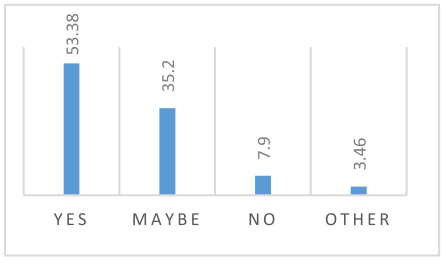

FIGURE 3. Users' reply to being more careful of what they post when being rated.

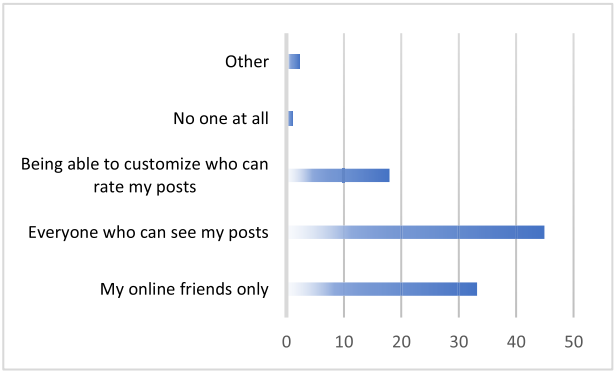

FIGURE 4. Who would users like to be able to rate the quality of their news you post.

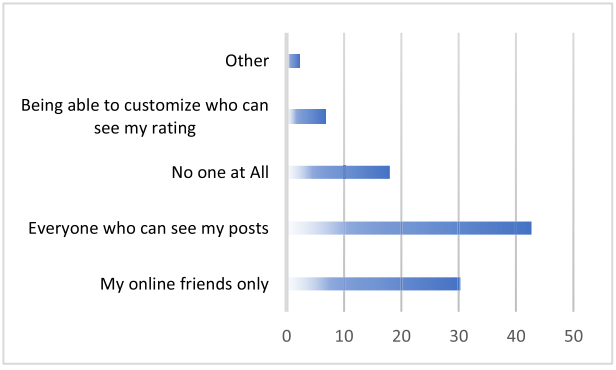

FIGURE 5. Who would users prefer to see/view their overall ratings on the quality of the news they post.

healthier online experience where users actively participate in increasing the quality of the shared and generated online content through a gamified environment.

B. PRIVACY

The participants expressed various privacy preferences regarding the availability of a rating feature that allows other users to rate the quality of the news they post or share. In general, they prefer to have full control over the visibility of their news posts quality ratings to other users and who can rate those news posts (see figure 4 and figure 5). This sheds the light on the importance of giving users the ability to customize their privacy preferences when designing a gamified news quality rating feature to provide them with a more satisfying experience that suits their various needs.

The cross-tabulation analysis in Table 2 shows that some participants would always prefer to know the identity of users who rate their news posts (49%). however, 13% of them mentioned that they would not prefer their identities to be revealed when they rate other users' news posts. Additionally, 14% of them would only prefer their identities to be visible when they give a positive rating.

On the other side, 33% of the participants prefer to reveal their identity when they rate the news post of other users whereas 29% of them would prefer their identity to be known if they provide positive ratings only. Additionally, 28 of them prefer not to show their identity when rating other users' news post regardless of the nature of their ratings (e.g. positive or negative).

TABLE 2. Users' privacy preferences on the visibility of their identities.

		Would you like other users to know your identity when you rate their news posts (e.g. by showing your username alongside with your given rating to them)?						
		Total	I would like to be able to modify what appears to them (e.g. adding a nickname instead of my username or real name)	No	Only when I give them a negative rating	Only when I give them a positive rating	Other	Yes
Would you like to know the identity (e.g. username) of users who rate your news posts?	Total Count	100	7	**28**	2	**29**	1	**33**
	No	15	1	7	0	2	0	5
	Only when a negative rating is provided	5	0	2	1	1	0	1
	Only when a positive rating is provided	26	2	7	1	11	0	5
	Other	5	2	0	0	0	1	2
	Yes, always!	49	2	**13**	0	**14**	0	**20**

This really give a clear view of the wide range of users' preferences when it comes to the visibility of their identities or knowing others' identities when rating the quality of the news being posted by them or by other users on social media platform. This also sheds the light on the importance of taking these various preferences into account by software designers when designing such a gamified rating feature to ensure a better user experience and satisfaction.

C. NOTIFICATION

The participants were asked if they would like to be notified by social media platforms when other users rate the quality of their news post and whether they have different preferences in this regard. 54% of them answered with yes and 15% said now. However, around 24% indicated that they would like to be notified when only a positive rating is given on the quality of their news posts. This is perhaps due to the positive feeling that users could gain from such positive ratings. The rest of the participants said they would like to be notified only when a negative rating is given. These various preferences indicate the need for a systematic design of the notification feature of news quality ratings that fits users' different needs to ensure a better user experience and satisfaction.

D. GAMIFICATION ELEMENTS FOR ONLINE MISINFORMATION

The participants were asked about their preferences regarding the use of gamification elements (e.g. points, rewards, punishments, badges and leader boards) in social media platforms (Table 3). The use of these elements is for the purpose of motivating users to take an active role in fighting the spread of misinformation on those platforms. At first, 78% of the participants indicated that the use of such gamification elements (e.g. points) should be an optional feature for all users and can be deactivated when needed. It should also be scoped to news posts only excluding any other types of posts or information shared by users (e.g. jokes) as indicated by 68% of the participants.

In addition, around 52% of the participants would prefer social media platforms to notify them when their number of points on the quality of their news posts is decreasing and offer them help to increase their points. For example, users can be offered a quick way to fact-check their news posts before publishing them or they can be asked to include a reference to their news posts.

Moreover, more than half of the participants (51%) think that when a user's number of points decreases to a certain level then they should be suspended from sharing news posts for a certain amount of time as a form of punishment. This type of punishment is shown to make users more careful and cautious about the quality of the news they post as indicated by 53% of the participants. However, 23% of the participants disagree with this notion of punishment. This could be due the feeling of restrictions they might experience on their freedom to use social media platforms.

Furthermore, the participants emphasized that users who reach or exceed a certain number of points on the quality of their news posts should be rewarded in several ways (Table 4). This can be in the form of digital badges given to those users to distinguish them as a trustworthy source of news (indicated by 67% of the participants). Another form of rewards to those users could be the ability to access more software feature than others.

However, the selection of rewards should be carefully designed as an ad-hoc rewards design could harm users experience. For example, the participants were asked about the idea of rewarding users (with high number of point) with the ability to collectively supervise and monitor the validity and objectivity of the ratings given on other users' news posts. However, only less than half of the participants (43%) agreed on that sort of rewards. This could be due to their feeling of being judged or controlled by a group of other users.

In addition, 75% of the participants mentioned that the existence of leader boards, as a gamification element to display usernames or IDs of users who have high number of points or badges on the quality of their news posts, can promote a more competitive environment for users and lead to an improved quality of news shared on social media.

This really gives a clear view of the need for systematic and novel approaches for the design of gamification elements that

TABLE 3. The participants' preferences regarding the use of gamification elements on social media.

No	Question	Agree	Neutral	Disagree
1	I should always have the option to activate and deactivate the rating feature on the news I post/share (i.e. if I do not want others to rate my news posts then I can easily deactivate the rating feature)	78%	14%	8%
2	Apart from news posts, the rating feature should always be deactivated on other types of information I post/share (jokes, personal posts, stories, etc)	68%	23%	9%
3	I would like social media platforms to provide me with the necessary information on how to gain more points on the quality of the news I post/share (e.g. information on how to verify news sources)	48%	43%	9%
4	More points on the quality of the news I post/share should be gained when I include the source of the news in the post (e.g. the URL of the source of my news)	48%	26%	26%
5	Social media platform should always notify me when my overall rating is going down and provide information on how to increase my points	52%	27%	21%
6	When a user's rating goes down beyond a certain limit, the user should be prevented from sharing/posting news for a certain amount of time	51%	26%	23%
7	Preventing me for a certain amount of time from posting/sharing news when my rating goes down makes me more careful about the quality of news I share	53%	29%	18%
8	News posts that can be rated should be given a different look or appearance than other types of information being posted (e.g. giving a different text color for news posts to indicate that they can be rated)	64%	17%	19%

TABLE 4. Reward types for users who reach a certain number of points on the quality of their news posts.

No	Rewards	Agree	Neutral	Disagree
1	Having a badge to indicate that this user is a trustworthy source of news information	76%	16%	8%
2	Unlocking more software features for them (i.e. the free use of paid features of the used social media platform)	67%	19%	14%
3	Granting them the ability to collectively supervise and monitor the validity of the ratings given on other users' news posts (e.g. filtration of subjective ratings)	43%	49%	8%
4	Having an online leaderboard to display names, IDs or nicknames of users who have high ratings and trustworthiness badges to increase the level of competition among users and improve the quality of news shared among users	57%	24%	19%

aims at minimizing the spread of misinformation on social media to fit users' various needs. Such a systematic design will help ensuring a better user experience and ultimately an increased quality of online generated content.

E. SOCIAL RECOGNITION

The respondents were asked whether being a socially recognized person (e.g. a celebrity) could affect the objectivity of peoples' ratings of your news posts (e.g. giving a high rating just because you're their favourite celebrity)? More than half of the participants (51%) answered with yes and 42% said maybe.

In addition, around 42% of the participants indicated that having a close relationship with someone (e.g. a family member) can affect the objectivity of the ratings they give on their news posts (e.g. always receiving a high rating by parents). This highlights the need to carefully cater for these social aspects when adopting gamification for misinformation on social media platforms. Failing to do so could lead to a negative impact on the quality of the ratings given on users' news posts thus, a potential failure of the whole idea of adopting gamification to limit misinformation spread on social media.

IV. MISINFORMATION-AWARE SOCIAL MEDIA

Figure 6 shows an initial application-independent conceptual framework for the design of a gamified misinformation-aware social media. It summarizes the previously discussed findings in section 3. While gamification elements can motivate users to take an active role in fighting misinformation spread on social media, users expressed different needs and preferences in relation to these elements that need to be carefully catered for by software engineers.

Users' needs and preferences have a wide range of variety regarding gamification elements from different perspectives that include; privacy, rewards types and selection mechanisms, social recognition, notification methods and user interface design and appearance. Catering for such various preferences can lead to a better employment of gamification for the aim of reducing misinformation spread on social media.

Ultimately, this will improve the quality of news posted on social media, users' engagement, satisfaction, experience and critical digital literacy. In the future work, the framework will be enriched by looking at any potential classification and natural grouping of users' behaviours regarding the adoption of gamification for misinformation spread and how to cater for each class of users. Additionally, a software engineering method to guide software developers to implement the proposed framework in practice will be proposed. Furthermore, as users' preferences and needs could change over time, the proposed framework needs to adapt to these behavioural changes to better fit users' needs and preferences. This sheds the light on the need for enriching the framework with run-time adaptation capabilities in future research.

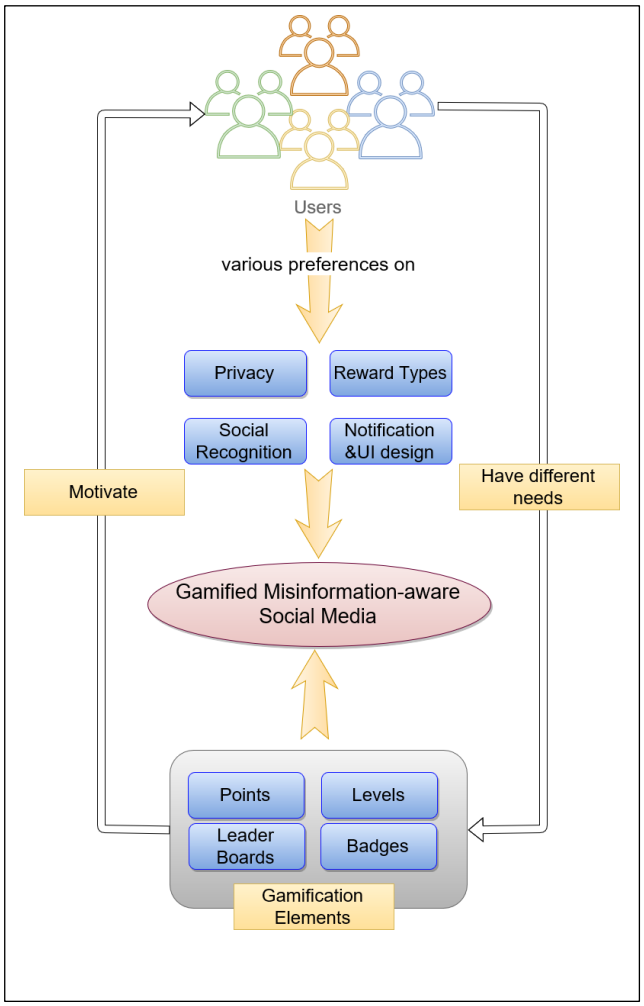

FIGURE 6. A conceptual framework for the design of a gamified misinformation-aware social media.

V. THREATS TO VALIDITY

Although the principles of carrying out quantitative studies were carefully followed by the author, the study might still hold three main threats to its validity:

- Although the adopted methodology was successful in finding and describing users' perception and preferences in relation to the use of gamification to combat online misinformation spread, there is still a possibility that it did not detect all the significant aspects that might impact their behaviours in this regard.
- A usual issue that faces researchers when making use of questionnaires is to find out whether all the respondents perceived and understood the questions the way intended. This threat was dealt with by doing a pilot trial on five participants who fit the study's inclusion criteria. Then some questions were reviewed and improved to make sure all respondents have nearly a shared understanding of the questions.
- The size of the study's sample (100 respondents) would be described as medium; a larger sample of subjects could produce more generalizable findings to larger population groups. More investigation of the study's results on a larger population group will be carried out in future research.

VI. CONCLUSION

In this paper, the author carried out and reported on a quantitative study to discover and investigate users' perceptions and preferences in relation to the use of gamification to fight online misinformation spread on social media. The findings indicated that users' perceptions and preferences relating to the context of this study highly varies and are influenced by several of factors. The results call for novel systematic approaches and methods to incorporate gamification elements into the design of social media platforms to fight misinformation spread. These approaches and methods should meet users' various preferences and needs and should highly cater for the aspects that affect their perceptions with regards to the context of this study. Availability of such systematic approaches can greatly improve the quality of users' news posts, users' online experience, the quality of online generated content and can ultimately lead to more misinformation-aware social media platforms.

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MALIK ALMALIKI received the B.Sc. degree in computer science from Taif University, Saudi Arabia, in 2008, the M.Sc. degree in advanced software engineering from Leicester University, U.K., in 2011, and the Ph.D. degree in software engineering from Bournemouth University, U.K., in 2015. He is an Assistant Professor in software engineering with the College of Science and Computer Engineering, Taibah University, Yanbu. His research interests include software engineering, adaptive software systems, and the engineering of social informatics, including the systematic design of software-based solutions considering their interactions with related institutional and cultural contexts.