Stress catcher application for mobile stress monitoring using questionnaire-based

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Article Info	ABSTRACT
	Nowadays, stress has become the main reason to cause health problems. The human's lifestyle has been increasing due to the fast development of technologies which help to improve performance and productivity indirectly increased the burden of human lifestyle. Many studies have done to identify the cause of stress and the effect of stress among university students. However, stress monitoring is not well mentioned in the previous works especially stress monitoring with questionnaire-based. Thus, this research tried to come out with a mobile application that fit to use to monitor the stress level by using a questionnaire. Mobile-D used to identify and develop the mobile application, namely as Stress Catcher. Mobile-D approach allows Test-driven development and it is suitable to use for mobile applications development. A prototype of Stress Catcher will function to prove the usefulness in human lifestyle.

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1. INTRODUCTION

Recently, due to the high impact of technologies, the speed of human lifestyle has become faster. Due to the high development speed, human are forced to have more production in a shorter period. When struggle in this situation, humans are under stress. Stress is a severe problem because it may endanger human's life. Stress can cause health problems such as emotional disorder and hypertension and may cause to death [1]. The study by [2] also proved that a person under negative stress (distress) will undergo depression and tend to commit suicide.

According to [3], student's performances in university are affected by symptoms of stress. Due to their academic and social demands in preparing their professional careers, they are survived in a very stressful environment [4]. Basically, juniors had higher reactions to stress due to they are fresh and try to adapt to a new environment [5]. In the field of gender, females seem will have higher level of depression, anxiety and stress compare to males due to some factors such as social role and physiological status [6]. Moreover, students originate from rural areas reported to score higher in depression, anxiety and stress scales [7] because normally they are hailing from a low socioeconomic background [8]. Although they undergo depression, anxiety and stress, [9] discovered that those with current financial struggles screen positive towards the situation. Family also plays a main role in determining emotional health status of youth.

Families that facing conflict such as divorce will affect their children to behave anxiety and psychological distress [10].

To prevent the negative effects of stress mentioned above, stress monitoring has become a precaution step to avoid the problem. However, to monitor stress effectively detecting the stress level before has become the priority task. There are many ways to detect stress level, either detecting it physiologically or psychologically. The most common way to detect stress level physiologically is measuring the heart beat rate of a person. Heart rate variability is the most accurate measurement to detect stress level [11-12]. Besides, detecting stress level psychologically is normally based on interview and questionnaire. The interview normally conducted by a professional psychologist and the psychologist can know a person stress level and help he/she to deal with stress. Stress monitoring is an important step to prevent stress from bringing side effects. With the aids of technology, study by [13] stated that wearable sensors can provide continuous biosignal measurements, which can be used to infer psychological stress arousal. In the study, wearable sensors are deployed on study subject to monitor their daily life by getting their biosignal measurements. In the end of this study, authors discovered that heart rate features can be related to stress arousal. The performance of a subject can be determined based on heart rate because a more stable heart rate represent the subject is not under stress. However, to monitor stress accurately overly complex or combine many wearable sensors is not suggested. In the study of [14], a protocol with different mentally stressful activities interleaved with regular session of deep breathing was developed to test the efficacy of deep breathing as relaxation activity. Three physiological sensors were used in the study, which is a heart rate monitor, a respiration sensor and an electrodermal activity sensor. As we know, human body will undergo several physiological and psychological changes when under stress [14]. These changes can lead to health problems and cause non-cardiac chest pain, hypertension, emotional disorders and lead to a dysfunctional breathing [1]. According to [15], improvements in sympathetic and parasympathetic homeostatic mechanisms, lung oxygenation and blood pH level can be achieved through deep breath exercise. Hence, study of [14] aim to identify the effectiveness of deep breathing exercise as a relaxation technique. They conclude that only performed the correct deep breathing way can help to relax human body. The aids of wearable sensors can help to improving subjects breathing methods to effectively evaluate stress and relaxed status.

Through the review, it can be concluded that with the aids of technology, stress able to be monitor. The development of stress monitoring system of mobile application can provide user more platforms to monitor their stress. In this study, a mobile application of stress monitoring system based on questionnaire is planning to be developed. The questions provide in the mobile application is set to be psychological-based to make the detection of stress level more accurate. To collect the system requirements, real survey is carried out to increase the reliability of psychological questionnaire.

2.   STRESS MONITORING USING QUESTIONNAIRE-BASED

In the development and validation of the stress of questionnaire, there are arguments about the questionnaire used. In regard to stress, a study by [16] defined stress in health care is affected by moral factors. They found that when people are prevented from doing 'good' or unable to do thing they ought to do, it will rise to a troubled conscience. Troubled conscience contributes human a positive force in developing moral values [17]. Conscience helps us to differentiate thing need to be done in a given situation or the actions are wrong or not based on ethics and moral values [18]. In this study, a set of Stress Conscience Questionnaire (SCQ) based on studies about personnel's experiences in ethically difficult situation has been designed [19]. The result of the study is positive. SCQ can detect the level of stress of conscience and appears to have acceptable psychometrics properties.

In addition, some studies show that psychosocial stress will affect health of employees [20-21]. In their studies, Psychosocial Working Conditions Questionnaires (PWC) is designed for stress monitoring. In the process of preparing PWC in the study of [22], the questionnaires were designed following these conditions: it is easy to fill in and interpret, it include evaluation of the basic work dimensions, demands control and social support in various profession [23, 21] and it should take into consideration potential effects of stress relating to mental and physical well-being. [22] later add in scales for measuring Well-Being (WB) and Desired Changes (DC) to exam physical and psychical well-being of a worker and offer worker to participate in evaluation and alteration of work conditions. The outcome of the PWC's results show potential of questionnaires in measuring stress level among workers.

Besides from stress monitoring among workers, some related studies also take adolescent as their focus group. This is because the experience adolescent stress has been systematically associated with a range of health compromising lifestyles and behaviours [24-25] including control of weight, physical inactivity, early and possibly heavy alcohol used and addicted to smoke. To prevent the experience of adolescent stress,

contribute issues of adolescent health, methodology of the measurement of stress has long been controversial. The issue of interview versus self-report questionnaire approaches has been debated [26]. In the study by [26], a set of Adolescent Stress Questionnaires (ASQ) has been designed. The study was carried out in two phases, involved generation of the adolescent stressor item using focus group and involved the development and psychometric evaluation of the revised ASQ based on these item. The ASQ can divide into five parts, which are basic demographic information, adolescent stressor experiences, state anxiety, state depress and self-esteem. The study has achieved their aims about the capacity of the ASQ to predict adolescent health status or adjustment in prospective studies.

Even though the capacity of scales of questionnaires to measure the stress level and the effect of health is not yet well understood, this study plans to strengthen the capacity of questionnaires by applying it into mobile application. With the help of technology, the collection of data will be easier, and public will more willing to help to answer the related questionnaires since mobile phone have become a necessary item in human's daily life.

3.   METHODOLOGY
The methodology used for the mobile application development is Mobile-D. Mobile-D approach consists of five stages: Explore, Initialize, Productionize, Stabilize and System Test & Fix [27]. Figure 1 shows the Mobile-D phases and stages for Stress Catcher development.

In the first phase, Explore, project establishment are defined through exploring of stress level among university students in UMS. Before starting the research, the functions used for detecting stress level was decided to use questionnaires compare to other measurements such as heart beat variability. This is because after reviewing previous studies, the main causes of student's stress are mostly coming from emotional problems. By answering selected items from the psychometric questionnaires, the results of stundent's stress level will be more accurate. The second phase is Initialize. In this phase, five existing stress monitoring mobile applications based on questionnaires were reviewed. The features of these mobile apps were compared, and a conclusion was made. Useful features will be conserved for Stress Catcher development while features that are not related will be eliminate. The reviewed of existing mobile apps provide a guideline for the future development of Stress Catcher.

The next phase is Productionize. Design of Stress Catcher was conducted in this phase. Features of Stress Catcher are designed according to the features that concluded in the previous phase and possible improvement also added. Test-Driven Development will also practice during the implementation of functionalities and the software used for development is Android Studio while testing will used Geny Motion. System testing would be applied during the implementation of functionalities according to the pre-established plan. Working version of the system is produced and validated through testing. In the last two phases which are Stabilize and System Test & Fix, the product will be finalize and Stress Catcher will be test by real user.
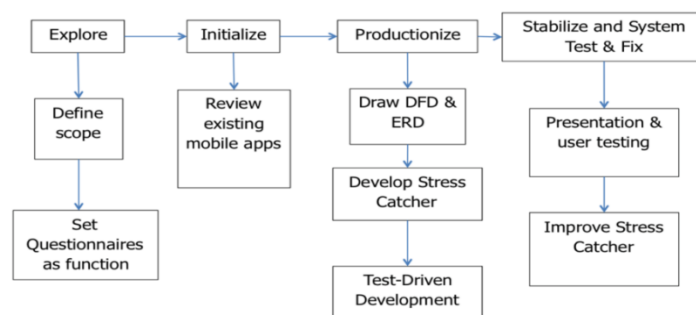

Figure 1. Mobile-D phases and stages for stress catcher

4.   PRELIMINARY STUDY
Before start the development of Stress Catcher, preliminary study of questionnaire-based was carried out. Five selected mobile applications from Google Play Store have been reviewed. After reviewing the most suitable user interface design of questionnaire-based mobile application, which is iDStress, the app is then use for collecting data for preliminary study. The flow, functionalities and use interface design of the five selected mobile applications also being clarify for development of prototype of questionnaire-based

stress monitoring mobile application. A set of questionnaires related to stress check according to demographic distribution also distributed to targeted unit to improve the accuracy of results. 20 students of UMS, which mean age is 22.5, range 20 – 25 years from different fields are selected using random techniques. The selected students are expected under stress. Selected students were asked to check their stress level by using iDStress and a set of questionnaires about stress. The questionnaire provided can be divide into three parts which are, symptoms of student stress, stress management techniques and demographic. The results of both questionnaires later will be compared and analysed. There are two results from the preliminary study. First, the results of iDStress are screenshot and the results are recorded. The results from the questionnaires distributed are tabulated into bar chart and the demographic data are tabulated into pie chart. Then, both results are compared and analysed. Going through Figure 2, we can see that most of the students define themselves under stress by fatigue or feeling tired. Actually this is one of the normal reactions by body when under stress. Stress occurs will affect student's feelings and emotions. However, none of them take change appetite as reaction of under stress.
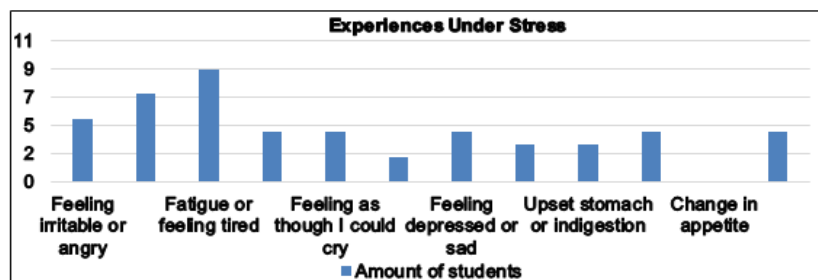

Figure 2. Experiences under stress by students

Based on Figure 3, when students are under stress, most of them choose surf internet/go online and listening to music as a way to distress. Many people believed that listening to suitable music able to soothe personal individual's feelings and hence degrade the level of negative stress [28]. None of them choose read, meditate/yoga and see mental health professional as solution to handle stress.
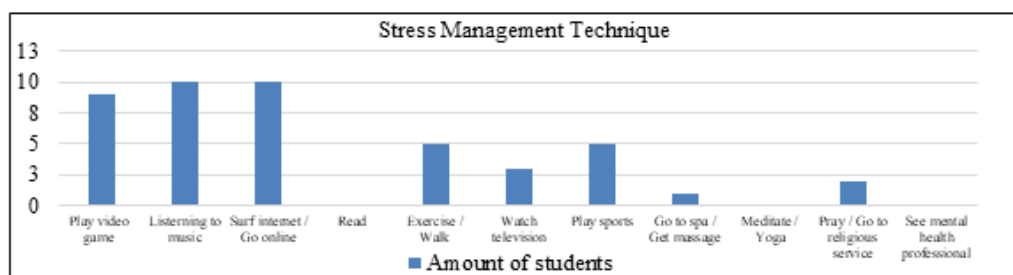

Figure 3. Stress management techniques

Going through the demographic of selected target, female students suffer higher stress level compared to male students. We can say that female might have more negative emotions towards university life. The group age, 22-23 shows highest percentage of stress level compared to other group age. This happened because most of the students among this age group are taking their final year project. The reason is then proved by the category of years of students.

The outputs of stress test using iDStress were shown in Figure 4. There are three possible outcomes, which are Resistance phase, normal stress level, Exhaustion phase, high stress level and Alertness phase, low stress level. The results proved that students of UMS do suffer moderate stress. This results significance with previous works by [29] using same method of questionnaire-based. The results also indicate that female do suffer severe stress compare to male. Therefore, the questionnaires used to develop Stress Catcher will be using psychometric questions, which developed by Psychological Assessment Resources, Inc.
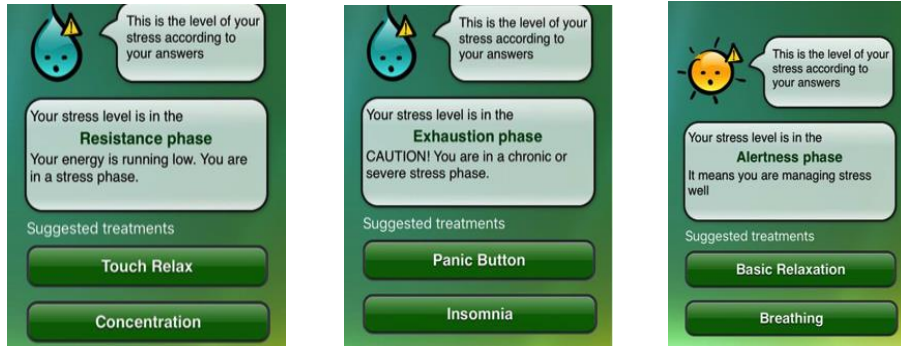
Figure 4. Sample outcomes of iDStress

5.   DEVELOPMENT OF STRESS CATCHER

When user runs the Stress Catcher, in the first interface, user will meet two options, which are login page and register page. User with an account can log in to the app by inserting correct email and password while user without an account can register a new account in the register page. By inserting a new email and password, user able to register an account and Stress Catcher will proceed to next interface, which is the user information page. In this interface, user is required to fill in some information, such as username, gender and age. After user complete to provide information, the user's details will be stored to database and the app will continue with user profile interface. User who fails to do so will not be able to proceed and warning messages will be prompted out and the user will be guided them to insert the correct data.

There are four features in this page. The first feature is upload user's profile picture. User can set profile picture of the account by selecting an image from photo gallery of the device. There are also three selections for user to continue Stress Catcher, which are edit profile, start stress test and history. When user select edit profile button, the app will proceed to a page that similar to user information and user able to change the profile information. A change password function also provided in the page. User can change the password by inserting correct original password. Moreover, choosing the history button will provide user to view the previous test score of the stress test if test were carried out before.

By select the start test button, the app will enter an interface where questionnaires are provided for users to carry out stress test. Four possible answers are provided which are a lot, often, always and never. Users are required to answer all of the questionnaires in order to know their stress level. 20 questions were prepared in this section. The next interface shows the result of the stress test. There are three possible results, which are alertness stage, resistance stage and exhaustion stage. Each result will provide explanations and suggestions for distress. Another function in Stress Catcher is history view. The user able to track all history test data and results of stress test through history view function. The previous score of stress test will be tabulated in graph by week and by month. There is also alarm function to notify users to run stress check according to their favour time. Users able to set the time that they wish to carry out stress check. Figure 5 shows the user interface of Stress Catcher.
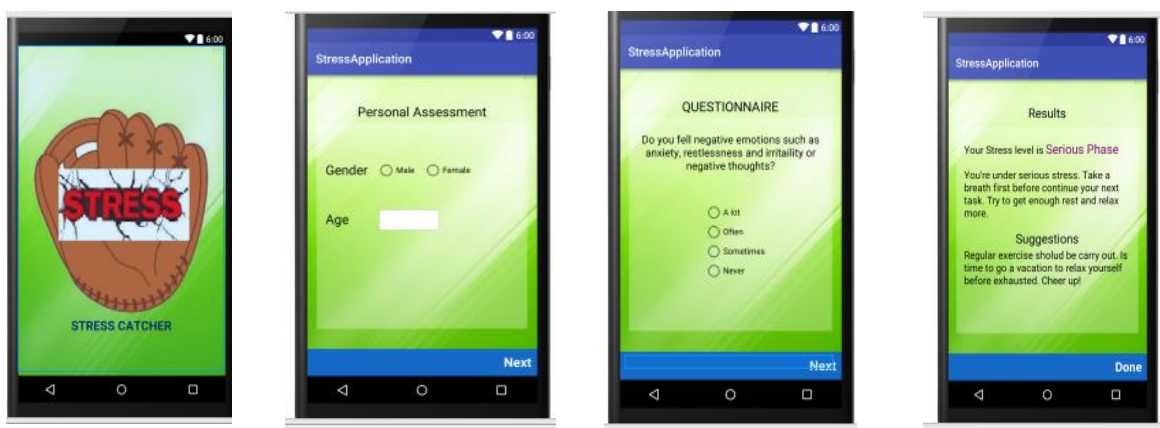

Figure 5. User interface and functionalities of stress catcher

6.   USABILITY TESTING

When Stress Catcher is completed, user testing was conducted. 10 participants were selected randomly to use and test Stress Catcher. User interface and mobile app features are mentioned in the usability testing. A set of questionnaires about user interface and mobile app features was prepared for collections of user perceptions and rating toward the app. Comments from the user testing will use as references to create a more complete Stress Catcher. The bugs and problems occur in the user testing also will be fixed in the next steps. 10 students of UMS which mean age is 22.5, range 20 – 25 years are selected using random techniques. Students selected were come from 3 faculties, Faculty of Food Sciences and Nutrition, Faculty of Engineering and Faculty of Computing and Informatics. Selected students were asked to check their stress level using Stress Catcher and the prepared questionnaires was distributed on the same time to let the user to comment and rate the app. The user tested the app according to the fields that explained in the system testing part. The results of the questionnaires then will be taken as the user rating about Stress Catcher and comments from user are recorded for future development of the application

7.   RESULTS AND DISCUSSION

According to the results of Stress Catcher in Table 1, female students were more susceptible of developing stress as compared to male students. This result was same with the preliminary study of this project. Moreover, it was observed that students that aged 24 experienced more stress compared to the students aged 23 and 22. This situation happened most probably caused by course workload and final year project since most of the students aged 24 are final year students.

Table 1. Statistics of Age and Gender in Term of Stress Level

Stress Level	Age			Gender	
	22	23	24	Male	Female
Normal	1	2	3	4	1
High	0	2	3	3	2

Next, the user's rating towards Stress Catcher was obtained though the questionnaires adapted from meCUE, which was a modular evaluation of key Components of User Experience. The structure of the questionnaires was based on the analytical Component model of User Experience by [30]. Four modules are included in the questionnaire, which were; Module 1: Product Perceptions, Module 2: User Emotions, Module 3: Consequences of Use, and Module 4: Overall Evaluation.

Each statement was assigned a numeric value for evaluation. The response with "strongly disagree" was assigned with the value of 1 while the response with "strongly agree" was assigned with the value of 7. Similarly, the other response options were assigned the values from 2 to 6 respectively. However, only the last statement which was "How would you rate the product overall?" and used for Module 4: Overall evaluation was different and had values within the range between -5 to 5 with a scale interval of 0.5. Hence, the arithmetic averages could be tabulated from all of the associated data and items.

Based on the statistics shown in Table 2, visual aesthetics was the highest value among module 1, which mean values achieved 5.83. In modules 2, user emotions, users show positive emotions toward Stress Catcher which has 4.42 mean values while for module 3, consequence of use, product loyalty mean value is higher that intention to use which are 4.77 and 3.53 respectively. For overall evaluation, user rating achieved 3.9 out of 5.0. Thus, we can say that Stress Catcher success to attract most of the user.

Table 2. Statistics of Each Module for Users Perception

Module	Subscale	Median	Mean values	Standard deviation	Minimum values	Maximum values
	Usefulness	5.67	5.63	0.51	4.67	6.33
	Usability	5.67	5.77	0.22	5.33	6.00
Module 1	Visual aesthetics	5.83	5.73	0.64	5.00	6.67
	Status	4.33	4.30	0.46	3.33	5.00
	Commitment	2.67	2.70	0.33	2.33	3.33
Module 2	Positive emotions	4.42	4.42	0.39	3.67	5.00
	Negative emotions	1.25	1.37	0.25	1.17	1.83
Module 3	Intention to use	3.33	3.53	0.59	2.67	4.33
	Product loyalty	4.83	4.77	0.39	4.00	5.33
Module 4	Overall evaluation	4.00	3.9	0.7	3.0	5.0

8.   CONCLUSION

The results from usability testing show that Stress Catcher does function in stress monitoring. Although it is still far away to monitor stress among university students by just using mobile app, these small steps such as improving the features mobile app based on questionnaires might be a giant leap in the future. Thus, the features that developed in this project should be included in future work. The features such as log in and sign up must not be ignored because it is important for user to have their own account so that they can monitor their stress level. Moreover, by having own account, the alert function able to remind user to stress check according to their favour time and help them to identify stress level more accurately because with more test data it will provide more accurate stress level. The history function should also preserve. By tabulating the results in graph, user can understand more about their stress level and have more awareness about their stress level when compare stress test result with date. For future work, to increase the accuracy of stress test, it is better to combine the stress test based on heart rate variability and the stress test based on questionnaire. This also improving mobile app features and functionalities. Some studies about stress test should be carried out to discover new methods for stress test and it might include in the future work of Stress Catcher. We believe that preventive is the better than cure. The Stress Catcher also can develop with some small game, which can be entertainment or as a way to distress for user. With enough rest and entertainment, stress can be handling easily before it causes negative effects.

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