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THE IMPACT OF COMMUNITY-BASED FIELDWORK EXPERIENCES ON FFECTIVE DOMAIN AMONG SOFTWARE ENGINEERING UNDERGRADUATES

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Abstract--- *This research is to examine the occurrences of affective domain learning when software engineering undergraduates were engaged in a community-based fieldwork to gather software requirements by investigating the effects of the fieldwork on different levels of affective domain. A quantitative approach using a quantitative survey was used in which data were elicited from a group of software engineering undergraduates consisting of 59 female and 38 male students. Through the survey, five levels of affective domain were investigated based on the following attributes: receiving, responding, valuing, organizing, and internalizing values. Several statistical analyses were used including descriptive analysis, paired t-test and Spearmen's correlation analysis. As a result, the descriptive analysis showed a high occurrence of each attribute at every level of the affective domain. Further analyses with a series of paired t-tests revealed that the respondents' knowledge of the five sub-procedures had improved significantly after the fieldwork. Whilst with Spearmen's correlation analysis, the results showed significant relationships between some levels of the affective domain, with respondents that expressing higher real feelings of frustration (such as due to bad planning or stakeholders' behaviour) tended to value the requirements gathering process to be highly important, and the same respondents also indicated that they would be willing to perform such a process in their final year project. The results of this study can be useful in making policy and curriculum for software engineering education at a higher institution. The study has shown that software engineering students will value and be more inclined to perform requirements gathering process in their final year project development if they experience and feel how importance the process themselves through a community-based fieldwork. In light of these revelations, more efforts are needed to integrate such a training approach into existing curriculum, which surely can help produce such undergraduates with higher graduate employability.*

Keywords---*Community-based fieldwork; affective domain; software engineering education*

I. INTRODUCTION

In higher learning, the term 'fieldwork' is defined as any curriculum component involving outdoor activities and learning from real experiences (Boyle et al., 2007). In this regard, based on a study by Stokes and Boyle (2009), which focused on geography and environmental science programs, such real-life experiences helped engender positive affective responses among students through dynamic teamwork and improved communication among students and teaching staff, ultimately

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leading to enhanced interest and motivation. As such, fieldwork has become an integral part of learning activities for such academic programs (Moscovici & Witt, 2018).

By contrast, such an approach is seriously lacking in the undergraduate programs in software engineering (Blake et al., 2014). Typically, the teaching and learning process of software engineering courses only takes place in the computer laboratory. Admittedly, engaging in fieldwork is important to the practitioners, as they have to deal with a host of human-related factors (Boulus-Rødje, 2015), the experience of which can help them gather better insights into understanding of how to achieve good designs of computer systems (Hughes et al., 1995; Regev et al, 2015), application systems (Randall et al., 2007), and human-computer interfaces (Doherty, McKnight & Luz, 2010). Nonetheless, the prevailing approach engaged by the practitioners is limited to ethnography-based fieldwork, where they mostly observe work practices of user groups and other user-related activities.

In light of this revelation, Blake et al. (2014) emphasize that fieldwork is a suitable approach for students, especially when they already have technical skills, to learn precise technical requirements by directly interacting or engaging with the real stakeholders or users. For such engagement to be effective, Blake et al. (2014) and Regev et al. (2015) assert that having good communication with stakeholders or users is of paramount importance. Interestingly, Blake et al. (2014)'s study at a public university in South Africa, community-based fieldwork involving several meetings with a community was found to be instrumental in improving students' interpersonal skills and meaningful learning among computer science students. Specifically, the students not only managed to practice their technical skills but also were able to improve their interpersonal skills through such fieldwork.

Even though interpersonal skills are not treated as one of the important learning outcomes, of late they have been duly recognized to be important for students' self-development and graduate employability (Stoke & Boyle, 2009). As acknowledged by many scholars, affective domain can be strongly affected through real experiences (Bharuthram, 2018; Munge et al., 2018; Dona dalle Rose & Serbati, 2018; Boyle et al., 2007), in which students' self-development, such as retention and perseverance, can be significantly improved (DeClue, 2014). Thus, real experiences through fieldwork may contribute to the improvement in affective domain that is likely to produce positive social change and self-development among students.

In fact, a review of the current literature will highlight a dearth of studies of fieldwork in the software engineering and computer science field. Despite the benefits of such an approach, no major efforts have been invested thus far in Malaysia to help encourage its application in the learning process (Mohammad & Eng Tek Ong, 2014). More importantly, more studies are needed to focus on the impact of fieldwork on student learning, encompassing both the affective domain and cognitive domain. Even though more emphasis is given to the latter, the former is beginning to be accepted as equally important in the computing curriculum, as evidenced by a number of guidelines on affective development recommended by many agencies, such as ACM/IEEE Joint Task Force Computing Curricula and Accrediting Board for Engineering and Technology (ABET) (DeClue, 2014).

Definitely, gaining some insights into fieldwork that addresses affective domain can be both interesting and challenging. As such, this study was carried out with the main aim to examine the impact of such an approach, namely the community-based fieldwork for requirements gathering, on student learning involving a group of Malaysian software engineering undergraduates at one of Malaysian public university.

The purpose of the study: to examine the occurrences of affective domain learning when software engineering undergraduates were engaged in a community-based fieldwork to gather software requirements by investigating the effects of the fieldwork on different levels of affective domain.

II. LITERATURE REVIEW

AFFECTIVE DOMAIN

Affective domain is another learning objective classification, apart from the cognitive and psychomotor domains, that was first introduced by a research team lead by Dr Benjamin Bloom in 1956 (Buissink-Smith, Mann, and Shephard, 2011). These classifications are used as a system to analyze and recognize how people can learn for different categories. Affective domain emphasizes on feeling, emotion, and a degree of accepting or rejecting the learning content. Boyle et al. (2007) characterize the affective domain as being indirectly linked to learning outcomes that deal with emotions, feelings, and values that may lead to higher motivation, eventually affecting student learning. This domain usually relates to human behaviour as the learning outcome.

According to Krathwohl, Bloom and Masia (1973), they have found different affective attributes in previous researches with specific terminologies such as interest, attitude, appreciation, values, and different set of emotions. They proposed affective domain taxonomy with each level contributes different objectives from as simple as giving attention, to a consistent character and inner self building. In principle, according to Buissink-Smith, Mann, and Shephard (2011), the current affective domain taxonomy comprises of five levels as follows:

a) Receiving - learners are open to new experiences and are willing to listen.
b) Responding- learners react and participate actively.
c) Valuing - learners attach values and express personal opinions.
d) Organizing - learners begin to develop a values system.
e) Internalizing values - learners adopt a belief system and behave consistently with it.

Oakland (1997) argued that affective domain taxonomy introduced by Krathwohl, Bloom dan Masia in the year of 1964 was less popular compared to cognitive domain taxonomy by Bloom in the year 1956. As of today, affective domain is still not discussed as heavily as the cognitive domain. Buissink-Smith, Mann dan Shephard (2011) stated that measuring affective domain will not be easy as the domain attributes are very subjective, hardly expressed, personal, hard to be observed and may change from time to time, hence making affective domain less popular.

PREVIOUS RESEARCH

Boyle et al. (2007) and DeClue (2014) were among very limited previous studies reported to be related to affective domain and/or either with fieldwork approach, computer science, or undergraduates. Most of other related studies were only focused on other subject of interests (Buissink-Smith, Mann, & Shephard, 2011; Bharuthram, 2018). One thing these previous researches had in common was that they were all keen to use open-ended survey questionnaires.

Rather than looking into each level of the affective domain in detail, previous affective domain-related studies mainly focused on exploring such domain based on students' affective responses that were collected from open-ended survey questionnaires (Boyle et al., 2007; DeClue, 2014). For example, Boyle et al. were more interested to explore the affective domain using positive affective responses from students that could be categorized into anticipation and reflection, knowledge and usefulness, and collaboration and enjoyment. On the other hand, DeClue was keener to investigate particular aspects of such domain, namely affective learning and persistence, among some computer science undergraduates.

Rahmat et al. (2018) has conducted a study on affective domain among undergraduates. Although the study is not related to fieldwork, or computer science, but the research approach, that examined each level of the affective domain using a quantitative survey, seems interesting. Given the lack of more specific research that focused at all levels of affective domain, we were more compelled to investigate the effects at each level of the affective domain using a quantitative questionnaire,

clearly a departure from previous studies in fieldwork and computer science field that mostly relied on open-ended survey questionnaires. The reason was because we did not want any attributes that we can set earlier to be missed during the survey. More specifically, we can examine each level of the affective domain in detail by focusing on the following affective attributes: acceptance (receiving), participation and emotion (responding), appreciation (valuing), self-confidence (organizing), and readiness (internalizing values).

Operational Definitions for Affective Domain Attributes

We provide operational definitions for each affective domain attributes for our study (see Table 1). For the first level of the affective domain, acceptance is defined as the perception that students hold after listening to some briefings and accepting the knowledge acquired through the fieldwork. In this study, we asked them whether the knowledge of sub-procedures that they possessed was gained from such an endeavour. To ensure the perception of acceptance was specifically associated with the fieldwork, a question was also used to ask students about the perception of their prior knowledge. The second and third attributes are participation and emotion attributes, respectively, which collectively refer to the second level of the affective domain. Specifically, the participation and emotion attributes refer to students' actions and reactions demonstrated during the course of the fieldwork, respectively.

For the third level of the affective domain, the ability to value something is measured by the appreciation attribute. Again, we used a specific question in the same questionnaire to help measure students' agreements on the value of importance that the students attached to 'requirements gathering' before the fieldwork. In the same questionnaire, self-confidence items are part of the questions that pertain to the organizing level, which is the fourth level of the affective domain. In principle, such a construct refers to students' multi-development that they firmly believe they are capable of achieving, namely their ability to describe, demonstrate, differentiate, justify, propose, and check.

Finally, the internalizing values level, which is the highest level of the affective domain, refers to a state in which the behaviours of students are likely to be consistent with a belief system that they hold. In this study, an item was used to ask the students about their readiness to implement requirements gathering in their final year project, which have to be carried out in their fourth year of study. The research objectives are to investigate the possibility of community-based fieldwork experience significantly affecting software engineering students' affective domain and to measure how significant the effects based on the five (5) levels of affective domain as presented in Table 1.

Table 1. Operational definition for affective domain attributes that we provide for our study

Level	Attribute	Operational Definition
1	Acceptance (Receiving)	Acceptance is the perception that students hold after the fieldwork, indicating that they have listened to the briefings given and accepted the knowledge during the fieldwork.
2	Participation (Responding)	Participation is the action of taking part actively in the fieldwork.
	Emotion (Responding)	Emotion is the active reaction when something happens during the fieldwork.
3	Appreciation (Valuing)	Appreciation is the value attached to 'requirements gathering' after taking part in a fieldwork.
4	Self-confidence (Organizing oneself)	Self-confidence is the multi-development of an individual, which refers to his/her belief that he/she is capable of doing certain related tasks skillfully after taking part in a fieldwork.

5	Readiness (Internalizing values)	Readiness is the state of being fully prepared for something and ready to behave consistently with it.

III. METHODOLOGY

A quantitative approach using a quantitative survey was used in which data were elicited from a group of software engineering undergraduates consisting of 59 female and 38 male students. Through the survey, five levels of affective domain were investigated based on the following attributes: receiving, responding, valuing, organizing, and internalizing values. Several statistical analyses were used including descriptive analysis, paired t-test and Spearmen's correlation analysis.

SAMPLE OF STUDY

Initially, the sample of the study consisted of 105 software engineering undergraduates enrolled in the MES3023 Software Requirements course for the first semester of the 2017/2018 academic session at the one of public university in Malaysia. However, the study sample was finally reduced to only 97 students, who voluntarily gave their consents to participate in the study.

RESEARCH METHOD

The study was conducted for four consecutive weeks, from the fourth week to the eighth week of the 14-week academic semester. The research method was divided into three phases as follows:

- Phase 1 (pre-fieldwork): In the fourth week of the academic semester, the students were given a briefing about the fieldwork that they had to conduct in groups to collect requirements data. A short lecture was then given by their respective lecturers on requirements gathering sub-procedures, and the students were instructed to develop some plans for their fieldwork accordingly.
- Phase 2 (during fieldwork): The students had to complete their fieldwork tasks within two weeks, starting from the sixth week. In the meantime, the lecturers played the role of 'consultants', with whom the students could contact using WhatsApp application or meet in person via an appointment. Students were instructed to submit their requirements gathering reports for the assessment of their course.
- Phase 3 (post-fieldwork): In the eighth week, questionnaire forms were distributed among the students who were willing to participate in the study. They were given 45 minutes to fill out the questionnaires. Data pertaining to students' responses were recorded onto a spreadsheet application and later analysed using R (version 3.4.2).

RESEARCH INSTRUMENT

Buissink-Smith, Mann, and Shephard (2011) have provided some descriptions on several different methods that can be used to measure affective learning. In our study, the affective domain attributes were measured using a survey questionnaire, to which the respondents were required to indicate the level of their agreements along a 4-point Likert's type scale using the following anchors in Table 2.

The questionnaire consists of two main parts:

- Part A (having 3 items): used to elicit information regarding students' demographics (namely age, gender, and academic background).

- Part B (having 21 items): used to collect information pertaining to the affective domain attributes. (See Table 3 for the items).

Table 2. The 4-point Likert's scale

Points of scale	Score
Strongly Disagree	1
Disagree	2
Agree	3
Strongly Agree	4

STATISTICAL ANALYSIS

In this study, several research objectives and hypotheses were formulated that entailed appropriate statistical techniques to analyse the survey data. Specifically, the descriptive analysis was used to identify the occurrences of affective domain attribute. Further analyses were conducted using paired t-test and Spearmen's correlation test to observe any connection among affective learning at different levels.

Table 3. 21 questionnaire items based on the affective domain attributes in Part B

No	Item
B1 (10 questions)	AC_1: I understand about sub-procedures *x* in requirements gathering BEFORE carrying out the fieldwork.
	AC_2: I understand about sub-procedures *x* in requirements gathering AFTER carrying out the fieldwork.
	(These questions were repeated for each sub- procedure in the requirements gathering, where x refers to aspects as follows: (a) understand the domain, (b) identify sources, (c) analyze the stakeholders, (d) select the techniques, and (e) elicit the requirements.)
B2 (2 questions)	P_1: I have participated actively in my team during the fieldwork.
	E_1: I can personally feel the frustration when some aspects of the plan did not go well during the fieldwork.
B3 (2 questions)	AP_1: I already understand the importance of requirements gathering BEFORE carrying out the fieldwork.
	AP_2: Now I know that requirements gathering IS really important AFTER carrying out the fieldwork.
B4 (6 questions)	SC_1: I can now describe some requirements gathering techniques that I have learned from my fieldwork experience.
	SC_2: I can now differentiate the requirements gathering techniques that I have learned from my fieldwork experience.
	SC_3: I can now justify why some requirements gathering techniques are more suitable than others.
	SC_4: I can now demonstrate how to perform some requirements gathering techniques.
	SC_5: I can now propose a suitable requirements' gathering technique if asked.
	SC_6: I can now check my friends' work on requirements gathering techniques and tell them what is right or wrong with such a technique.
B5 (1 questions)	R_1: I will definitely conduct requirements gathering in my final year project.

IV. RESULTS AND DISCUSSION

DEMOGRAPHICS OF RESPONDENTS

Descriptive analysis results showed that the sample study was comprised of 59 female and 38 male students. In terms of academic background (prior to enrolling in the undergraduate programs), 61 students were from the science background, having diplomas, higher education certificates, and matriculation certificates in science. The remaining 36 students were from the arts background, with diplomas, higher education certificates, and matriculation certificates in arts. Their ages ranged from 21 to 23 years old. Table 4 summarizes the demographics of the respondents in this study.

Table 4. Summary of academic background (qualification) and gender

Academic Background	Background Stream	Female	Male
Matriculation Certificate	Science	25	18
	Arts	1	1
Diploma	Science	5	9
	Arts	2	0
High Education Certificate	Science	2	2
	Arts	24	8
TOTAL		**59**	**38**

RESPONDENTS' PERCEPTIONS OF AFFECTIVE DOMAIN ATTRIBUTES

The respondents' responses to the second part of the questionnaire (Part B) were analyzed to measure their agreements with the affective domain attributes, to which they had exercised in the fieldwork. Overwhelmingly, more than 83 respondents (between 85.6 % and 95.9%) agreed that they had listened well during briefings and accepted the knowledge of all the five sub-procedures learned and acquired through the fieldwork. See Figure 1.

Likewise, 90 respondents (at 92.8%) agreed that they had participated actively in the fieldwork. In addition, 85 respondents (at 87.6%) agreed that they had felt some frustrations when their plans did not go smoothly. Meanwhile, 93 respondents (at 95.9%) agreed that they valued the requirements gathering process to be extremely important for their learning. The results are shown in Figure 2.

Figure 1. Results regarding the acceptance (receiving) of five sub procedures AFTER fieldwork

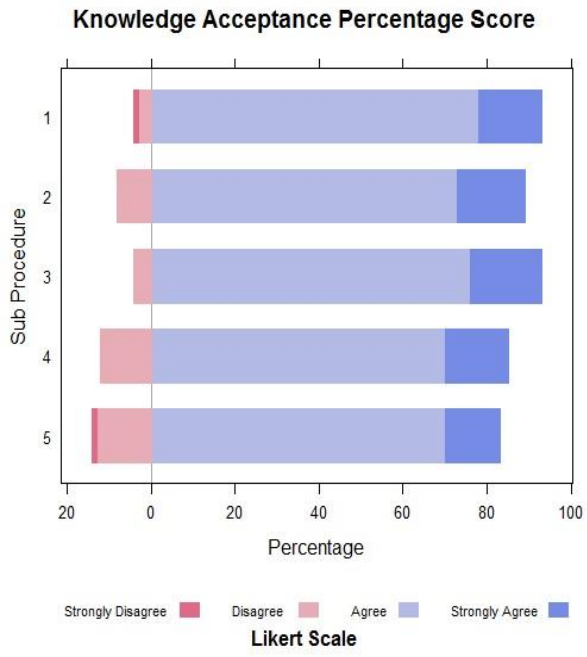
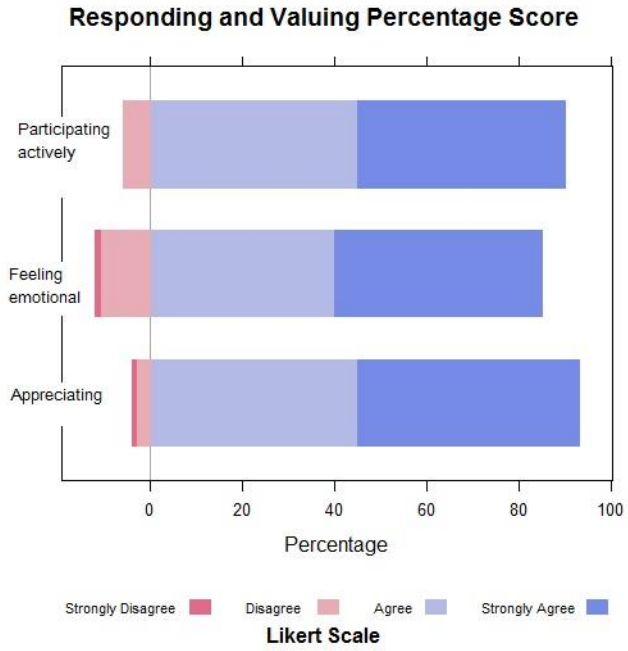


Figure 2. Results regarding responding and valuing



Clearly, the above findings indicated that all lower level affective domain attributes, namely acceptance, participation and emotion, and appreciation, were highly rated by the respondents, suggesting that students view such attributes to be important in helping them to effectively learn software requirements specifications. In addition, a series of paired t-tests was performed to determine if there were any significant differences in the respondents' knowledge of the five sub-procedures before and after the fieldwork (as presented in Table 5). Interestingly, the tests revealed that the differences in such knowledge were significant, indicating that the fieldwork had a profound impact on their learning of the subject matter. For example, there was a significant difference in the scores for knowledge acceptance of understanding domain after and before fieldwork (Mdiff= 0.71, t(96)= 9.17, p<.001). Such findings underscore the imperative of fieldwork to help students learn the five sub-procedures effectively, which are deemed vital for the first three levels of the affective domain.

Table 5. Results of paired t-test on knowledge acceptance of the five sub-procedures (before and after the fieldwork)

Sub Procedure	Mean Diff.	*t*-value	*p*-value
Understand domain	0.71	9.17	<0.001
Identify sources	0.63	7.92	<0.001
Analyse stakeholders	0.67	8.38	<0.001
Select techniques	0.55	7.60	<0.001
Elicit requirements	0.59	7.61	<0.001

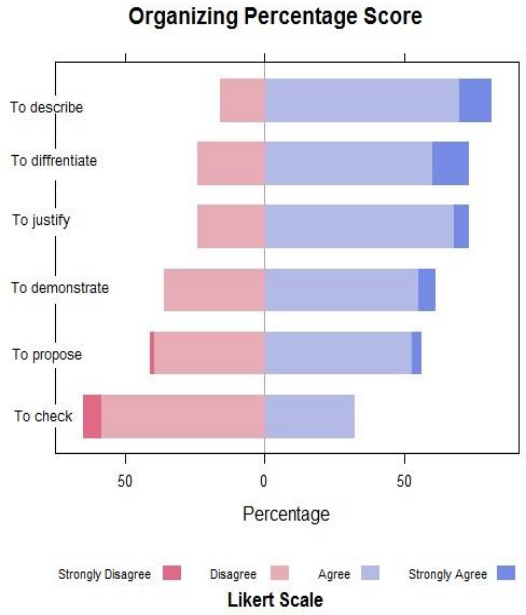
NOTE. All computed significant values were lower than 0.05, indicating that respondents' knowledge acceptance had improved significantly after the completion of the fieldwork. The value of df = 96.

Figure 3 shows respondents' agreements on a selection of skills that they believed they had gained from the fieldwork. Evidently, higher levels of their agreements were observed for lower cognitive abilities, such as the ability to describe and to differentiate.

In contrast, other higher cognitive abilities, such as the ability to propose and to demonstrate, garnered relatively lower agreements, evidenced by more than half of the respondents agreeing with the existence of such affective attributes. More than half of them, however, were not confident enough to check their peers' work (Balakrishnan et al, 2014).

More revealingly, a majority of the respondents (at 83.5%) expressed their readiness to apply what they had learned from the fieldwork in their final year projects. See Figure 4. Taken together, the above findings suggest that carrying out fieldwork will significantly benefit most students, in particular for affective attributes at the higher level of the affective domain.

Figure 3. Results regarding organizing oneself with skills they believed were gained from fieldwork

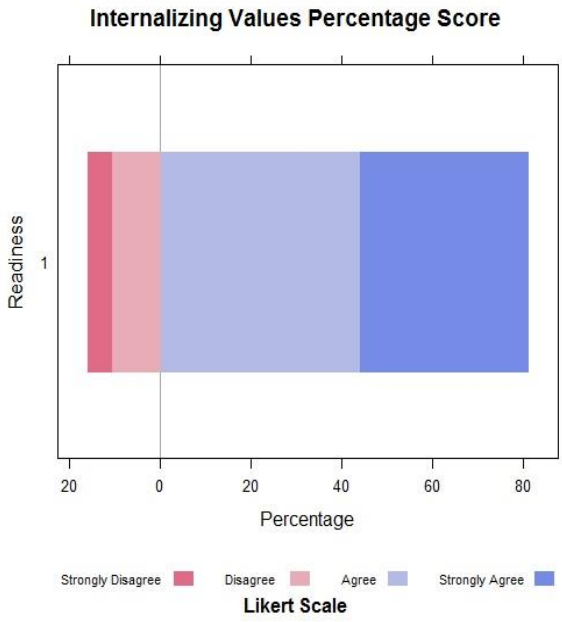


Relationships between affective domain attributes

Arguably, discerning the relationships between affective attributes are not easy, given the complexities of such associations (Buissink-Smith, Mann, & Shephard, 2011). Nonetheless, progressing from one level to the next higher level of the affective domain hierarchy was said not to be automatic and possessing some attitudes does not necessarily yield some expected behaviours.

Interestingly, in our study, the results of the Spearmen's correlation analysis showed significant relationships between some levels of the affective domain. For example, respondents who had real feelings of frustration when their requirements gathering plan went wrong tended to value the requirements gathering process to be highly important ($r = .24$, $p = .02$), and in turn they indicated that they would be willing to perform such a process in their final year project ($r = .45$, $p = .001$).

Figure 4. Results regarding readiness to perform requirements gathering during final year project



V. CONCLUSION

In this study, we investigated the effects of community-based fieldwork on student learning by focusing on five different levels of the affective domain. As demonstrated, students' experiences in the community-based fieldwork helped them attain all the five affective domain attributes, which are valuable for their self-development as software engineering undergraduates (Balakrishnan, et al, 2014). Moreover, students with bad experiences during the fieldwork, perhaps due to improper planning or other possible factors, had valued the importance of the learning process and the importance of the requirements gathering activity more than other students, and in turn were more willing to perform requirements gathering activity during their final year project (Meng & Idris, 2015). Clearly, such fieldwork is indispensable to their learning, and thus more efforts are needed to integrate such a training approach into existing curriculum, which can help produce undergraduates with higher employability.

VI. LIMITATION

This survey was only conducted in a single public university that has students follow a fieldwork for requirements gathering mini project. Different universities at different regions that have software engineering program are welcomed to use similar fieldwork approach so that this survey can be replicated.

VII. ACKNOWLEDGEMENT

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