The Influence of Gender, Personality, Cognitive and Affective Student Engagement on Academic Engagement in Educational Virtual Worlds

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Abstract. Educational virtual worlds (EVWs) are emerging as immersive learning environments that allow students to engage in experiential learning. However, understanding whether individual student differences influence learning behaviours and adapting the EVW accordingly has not been extensively investigated. This paper reports an experimental study with 115 undergraduate students to explore the link between their gender, personality, cognitive and affective engagement in relation to their academic engagement, measured by a quiz after using the world. We also explore whether providing hints can improve their academic engagement in the EVW. Only personal support (a factor of affective engagement) and intrinsic motivation (a factor of cognitive engagement) were found to be related to the quiz score. Also the personality dimension of Openness indicated student propensity to accept support.

Keywords: Educational virtual world · Personality · Big five factor
Affective engagement · Cognitive engagement · Academic engagement

1 Introduction

Virtual worlds are emerging as a potential platform for a variety of applications especially in the field of education and learning. A virtual world used for education is known as an educational virtual world (EVW). These computer-simulated environments are typically three-dimensional (3D) and have similarities to the real world, usually in the form of physics, movement or topography that enhance the illusion of presence. Though the merits of 2D versus 3D will depend on the learning context [1],

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presence in 3D environments can aid experiential learning and can therefore be used to enhance education [2].

Educational virtual worlds have been used successfully in the past, most notably the online virtual world of Second Life that allows users to create avatars to represent themselves and interact with other users in the virtual world [3]. EVWs have capability to offer freedom of navigation for students to learn in their own pace and in their own way, providing features of remote learning [4]. These findings are further supported by Falloon [5] in reference to the features of educational virtual worlds enabling students to exhibit higher order thinking skills along with better communication.

Immersive, graphically rich learning environments seem compelling to increase student engagement, a factor associated with learning. However, as with the use of any educational technology, the technology itself does not guarantee learning. For example, the value of three-dimensional over two-dimensional will be dependent on the concepts to be learnt [1]. As well as different technology affordances, demographic factors such as age and gender and individual factors such as personality and engagement, have been found to significantly predict the way students learn new concepts and achieve the learning outcomes [6, 7]. The understanding of student personality traits and how well they are engaged with the content on different levels can provide additional insight in order to design educational virtual worlds that can deliver enhanced learning outcomes for users. Students with different personality traits and engagement levels may differ in the way they learn and what support they find useful. This study is guided by following research questions:

(1) *Does an individual's gender, personality, level of affective engagement or level of cognitive engagement influence their performance in a quiz after using an educational virtual world?*
(2) *Does the provision of hints assist some individuals more than others?*

This paper is structured as follows. The next section provides background to the study. Methodology appears in Sect. 3, followed by results and discussion in Sects. 4 and 5 respectively. The conclusion, future work and implications appear in the final sections of this paper.

2 Background

Understanding of personality traits in students can help to resolve issues of academic underachievement amongst students. Extensive numerous research studies have been conducted in past to examine the relationship between personality traits and performance [7–9]. For measuring personality, the most commonly used instrument is the Big Five Factor (BFF) model. The personality traits in this model are Openness, Conscientiousness, Extroversion, Agreeableness, Neuroticism sometimes also called OCEAN collectively [10, 11]. Openness trait relates to creativity while Neuroticism relates to emotional stability. Conscientious individuals have traits of being more organised, disciplined and hardworking. Agreeableness represents people with more sympathetic, thoughtful and cooperative nature. People with extravert trait are outgoing

and friendly people who tend to form more social connections as compared to their introvert counterparts [12].

A related study done by Chamorro-Premuzic and Furnham [13] for university students emphasised that conscientiousness is a strong determinant of academic results. These ideas were further extended in another study in a school setting where they found that students with conscientious personality trait performed better in science subject [9]. Furnham and Monsen [9] also claimed that people with extravert personality are more interested in studies and perform better if they feel free and have more sense of freedom. Similar results have emerged from another study that points out that people with high level of openness and conscientiousness achieve success at university level [14]. In same direction, Eyong and David [7] revealed that conscientiousness and agreeability traits are associated with the performance of secondary school students in positive manner and focused on promoting the need to encourage students to gain these behavioural traits for better academic achievements.

Student engagement plays a vital role in shaping academic performance in various settings. Disengagement is considered to be a key factor influencing student dropout rates in schools. Understanding of students' engagement in learning context can provide new perspective to narrow the gap of academic achievements.

Student engagement is a multidimensional construct with four primary dimensions namely academic, behavioural, emotional, and cognitive engagement [15]. The first two types of engagement (academic and behaviour) can be objectively measured. Academic engagement can be measured using the variables such as time spent to complete the task or grades received. The level of behavioural engagement of a student can be represented by looking at their attendance, participation in class and extra-curricular activities. The other two types (cognitive and affective), also known as internal forms of engagement are as influential as academic and behavioural engagement but there are not sufficient research evidences to confirm their link with academic performance because of their less observable indicators. The cognitive engagement involves indicators related to self-learning, future goals and intrinsic motivation while affective engagement corresponds to the relationships with peers and teachers [16].

Many studies have explored the relationship between student engagement and student achievement [6, 17, 18]. Fredricks and Blumenfeld [15] demonstrated the positive association between engagement and academic achievement. A few other studies also suggested similar results but the links seemed to be weaker [6, 19].

3 Methodology

To answer the above research questions, we conducted an online study approved by the Macquarie University's Human Research Ethics Committee involving students using an educational virtual world. All participants were invited to participate via the online recruitment program of the Psychology Department and could choose our study to receive half an hour course credit for their participation.

3.1 Experimental Design

To measure whether tailored hints provided by the system improved quiz performance, participants were divided into four groups. Group formation is illustrated in the Fig. 1. Each group used the EVW in two separate rounds. In the first round, Group 1 and Group 2 did scenario 1 while Group 3 and Group 4 did Scenario 2. For second attempt (as shown in part D) Group 1 did scenario 2 receiving hints, referred to as S1/Hint group (S1H). Group 2 did scenario 2 without hints is referred to as S1/Control group (S1C). Group 3 did scenario 1 and received hints is referred to as S2/Hint group (S2H). Group 4 did scenario 1 and did not receive hints referred to as S2/Control group (S2C).

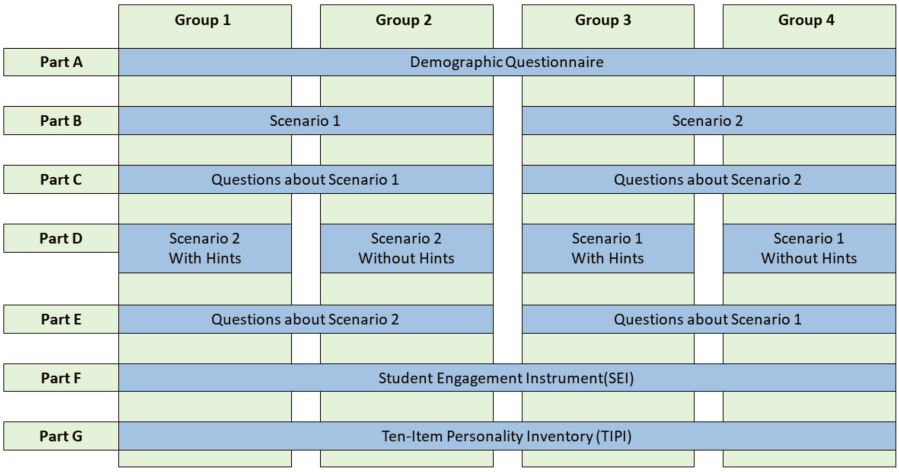

Fig. 1. Experimental groups

3.2 Materials and Methods

The EVW is an island known as Omosa, that is facing a problem with a certain species of animals dying out. The purpose of Omosa is to help students gain knowledge about biology and to learn and practice science inquiry skills. Omosa represents a fictitious island with five main locations: village, research lab, hunting ground, animal counting station and weather station that can be visited by students. There are virtual agents present on main locations that provide information to the students. Students may gather information by talking to these virtual agents and through observation. The animals that inhabit the island are intelligent agents that live in predator-prey relationships and demonstrate emergent behaviours according to the agent-based models that drive them. Omosa has been developed to be used over several class periods and to be used in conjunction with workbooks, use of Netlogo simulation software and classroom activities. For the purpose of this study to test our hints, the value of capturing cognitive

and affective engagement and personality, we conducted a shorter study with undergraduate students that involved their navigation around the world, the collection of data and conversation with the Omosan virtual people and observation of the virtual animals. After their visit to Omosa, students were asked to answer a pre-defined set of questions based on the facts about the island covering scientific concepts about biological systems. Participants were allowed to navigate through the island following any path.

3.3 Procedure and Data Collection

Following informed consent, the study procedure took around 30 min and consisted of the following parts:

I. Demographic questionnaire
II. Interaction with EVW
III. First EVW quiz
IV. Second interaction with EVW
V. Second EVW quiz
VI. Personality Traits Questionnaire - Ten Item Personality Measure (TIPI)
VII. Engagement Questionnaire - Student Engagement Inventory (SEI)

The study started with demographic questionnaire with participants. The demographic questionnaire included questions to extract participants' information related to gender, cultural group, age, and how many hours they play computer games per week.

The next step in this study involved use of virtual world by participants. There were two interactions with the EVW depending on which group participants belonged to, as illustrated in experimental design section. The educational virtual world described above in methodology section was used for this purpose.

Parts III and IV involved assessing the participants performance by asking ten relevant questions based on the information that was collected during navigation of virtual world either by conversing with the characters or by observing the environment. After both scenario, a set of ten questions were asked from each participant from all four groups (S1C, S1H, S2C, S2H) as illustrated in Table 1. One of the example of a question was, "What do the villagers usually eat?" The answer to this question can be obtained from one of the villager in the virtual world. We used the number of correct answers to categorise participants into groups to represent their performance in educational virtual world based (Low = 1 to 4 correct; Medium = 5 to 6 correct; High = 7 or more correct).

The online nature of study allowed more people to participate in their own time and place. The questionnaire was made using Qualtrics, a web site where surveys can be created. The virtual world was embedded within the survey to let participants complete it without the need to leave the survey website.

After each scenario, we asked participants how much on a scale of 1 to 5 they found the experience enjoyable, with 1 being not enjoyable, and 5 enjoyable. Participants were also asked to elaborate why they thought the experience was enjoyable or not. The participants were also asked for usefulness of the hints, if they belonged to a group where hints were given for second scenario. These strategies provide us with the possibility for better comprehension of the behaviour of participants and more sophisticated interpretation of data during analysis.

Participants also answered the Ten Item Personality Instrument (TIPI) that consisted of 10 questions. TIPI allows for a quick measurement of the Big-Five personality dimensions, extraversion, agreeableness, conscientiousness, emotional stability, and openness to experiences [11]. The instrument was included to gather data to determine the influence of participant's personality on the performance and the likelihood of being engaged with the virtual world. To measure cognitive and affective engagement we used the Student Engagement Instrument (SEI) [16]. SEI was designed for use on students in middle school, so we modified it for university students. For example, we replaced the word "school" with university. SEI includes 32 items, nineteen items to measure affective engagement and fourteen to measure cognitive engagement. Participants responded to statements by rating their level on likert scale of 1–4 with 1 indicating that they never felt or acted that way, and 4 indicating that they certainly acted that way.

The student's behavioural engagement was captured via their interactions within the world consisting of how many characters they spoke to, where they had visited, how long they were in the world, the number of navigation steps and navigational patterns. Academic engagement was captured via the number of correct answers (min = 0, max = 10) to the 10 questions in the quizzes given after using the EVW. The virtual world was deliberately laid out in such a way that participants may not always know what to do, or where to go next. Omosa is a fictitious world and thus the answers to the questions could not be based on prior knowledge. We did not ask students to self-report about behavioural or academic engagement.

To facilitate analysis, the data were transformed and prepared. Preparation included checking response values were valid and complete. First, data regarding participants' demographics were tabulated. This information was used to report the demographic characteristics of the participants. The demographic characteristics of age, gender, cultural group were also relevant to the current study. We calculated a score from 0–10 for each quiz. The quizzes included multiple choice questions, with one correct answer that received a score of 1. To answer the research questions and to identify potential significant relationships between the categorical variables such as gender, cultural groups, personality, different types of engagement levels and quiz scores, we calculated chi-square test on results.

4 Results

A sample of 115 undergraduate Psychology students participated in our study. Of the total number of respondents, 37 were male and 78 were female. Ages ranged from 17–33 with the mean age of these participants was 19.80 and standard deviation of 2.84. Only 43.48% of participants played computer games, for an average of 7.35 h per week, ranging from 1 h to 50 h. Groups 1, 2, 3, and 4 had 37 (S1H), 29 (S1C), 25 (S2H) and 24 (S2C), participants, respectively. Thus, a total of 62 were assigned to hints and 53 to control. While the Qualtrics randomiser equally distributed participants into each group, some participants chose to stop participation (possibly due to having to download and install the Unity3D EVW). The results regarding cultural background are shown in Table 1. We can see that there are two largest cultural groups "Oceania" (which includes Australia) and "South East Asia".

Table 1. Cultural background

Cultural group	%	**N**
Oceania	20	23
Northern-Western European	13.91%	16
Southern-Eastern European	10.43%	12
North African and Middle Eastern	9.57%	11
South-East Asian	20	23
North-East Asian	3.48%	4
Southern and Central Asian	6.09%	7
People of the Americas	0.87%	1
Sub-Saharan African	0.00%	0
I don't identify with any cultural group	15.65%	18
Total	100	115

4.1 Personality Data

Means were calculated for each of the five personality dimensions for each individual. We categorized each dimension into low, medium and high for better identification of patterns and profiles. Table 2 shows the data, further categorized by gender. Chi-square tests revealed no significant differences for gender and personality except for gender and agreeability $X2\ (N = 115) = 10.31$, $p = 0.04$. A relationship between game playing characteristic and personality was also observed. Out of 65 people who play games, 39 (69.64%) are highly agreeable suggesting an association between agreeableness trait and playing games.

Table 2. Categorised personality results (L = low, M = medium, H = High)

	Openness				Conscientious				Extraversion				Agreeableness				Neuroticism			
	L	M	H	Total	L	M	H	Total	L	M	H	Total	L	M	H	Total	L	M	H	Total
Female	9	27	42	78	8	38	32	78	20	32	26	78	3	29	46	78	24	28	26	78
Male	3	11	23	37	3	19	15	37	10	14	13	37	3	24	10	37	7	9	21	37
Total	12	38	65	115	11	57	47	115	30	46	39	115	6	53	56	115	31	37	47	115

4.2 Engagement Data

Affective engagement (AE) is comprised of: Teacher-Student Relationships (TSR) (mean = 1.66, s.d = 0.62), Peer Support at School (PSS) (mean = 1.73, s.d = 0.64), Family Support for Learning (FSL) (mean = 1.72, s.d = 0.63), Cognitive engagement (CE) is comprised of Control and Relevance of School Work (CRSW) (mean = 1.21, s.d = 0.45), Future Aspirations and Goals (FG) (mean = 1.78, s.d = 0.62), Intrinsic Motivation (IM) (mean = 1.97, s.d = 0.73). For comparison we categorized the mean results into low, high and medium as shown in Table 3. After averaging the results for the three components in each type of engagement, 58 (50.43%) participants had high AE and 57 (49.57%) had low AE; 77 (66.96%) participants had high CE and 38 (33.04%) had low CE.

Table 3. Number of participants in engagement categories. **TSR** = Teacher-Student Relationships, **PSS** = Peer Support at School, **FSL** = Family Support for Learning, **CRSW** = Control and Relevance of School Work, **FG** = Future Aspirations and Goals, **IM** = Intrinsic Motivation

Category	**TSR**		**PSS**		**FSL**		**CRSW**		**FG**		**IM**	
Low < 3	48	41.74%	43	37.39%	43	37.39%	93	80.87%	37	32.17%	33	28.70%
Mid >=3	58	50.43%	60	52.17%	61	53.04%	20	17.39%	66	57.39%	53	46.09%
High >=3.5	9	7.83%	12	10.43%	12	9.57%	2	1.74%	12	10.43%	29	25.22%

Cross tabulations showed that out of 38 participants with high cognitive engagement, 84.21% have high affective engagement and out of 77 participants with low cognitive engagement, 67.53% also have low affective engagement. Participants with high affective engagements, 56.14% of the 57 are also highly engaged cognitively. Similar results are observed for all groups, including those receiving hints or not. Chi-square tests revealed significant relationship between cognitive and affective engagement $X2$ ($N = 115$) = 27.25, $p = 0.00$.

Chi-square tests reveal significant associations between some personality dimensions and engagement levels: affective engagement and disorganised $X2$ ($N = 115$) = 20.64, $p = 0.00$; cognitive engagement and disorganised $X2$ ($N = 115$) = 40.15, $p = 0.00$; cognitive engagement and conscientiousness $X2$ ($N = 115$) = 9.24, $p = 0.01$.

Cross tabulations showed that participants with low affective engagement most commonly (44.83%) chose the Likert scale option “agree a little to being disorganised and careless. Whereas, participants with high affective engagement most commonly (33.33%) chose “disagree moderately” to being disorganized and careless. This suggests that organised people are more affectively engaged. Regarding being disorganised, 37.66% of participants with low CE “agreed a little” along with 10.39% who “agreed moderately”, whereas 47.37% participants of participants with high CE chose ‘disagree moderately’ and 5.26% chose ‘disagree a little’. Highly cognitively engaged participants, were also more likely (60.53%) to score high for the conscientiousness personality dimensions. These results show a link between being organised and conscientious and is related positively to being cognitive engaged.

Chi-square tests revealed a significant relationship between game playing behaviour and cognitive engagement X2 (N = 115) = 4.88, p = 0.03. People who do not play games were more cognitively engaged. There were 38 people with high cognitive engagement. 71.05% of them do not play games. From 77 (66.96%) participants who are low on cognitive engagement category, 50.65% play games.

4.3 Performance Scores

For each treatment group we calculated the average number of correct answers in Table 4. The categorized quiz scores are compared with levels of affective and cognitive engagement in Table 5.

Table 4. Correct answers for each Group

Group	N participants	Avg.	Quiz 1 correct answers	Quiz 2 answers
S1Control	29	5.43	4.5	6.4
S1Hints	37	5.6	4.6	6.6
S2Control	24	4.46	3.8	5.2
S2Hints	25	5.74	5.0	6.5

Chi-square tests comparing gender with quiz scores and engagement variables for any scenario did not reveal any significant differences. Cultural group shows statistical significant difference in results with quiz 2 score X2 (N = 115) = 29.93, p = 0.04. Oceania (27.27%) and Northern Western European (21.82%) groups are the highest scoring groups for quiz score 2 as compared to other cultural groups while for first scenario there were far less people in high scoring group and most participants belonged to Oceania group (35.71%). There was also a link between quiz scores and playing games in both scenarios. People who played games tended to perform less 46/65 (70.77%). This is further confirmed from second scenario where 61.76% students scored mid and 29.23% students scored low. The results do not show any statistical differences for CE and quiz scores for any of the attempt but looking at the data we can see that 65.79% of high CE people scored low in first scenario but this number reduced to 23.68% for second scenario.

Table 5. Quiz 1 (top) and Quiz 2 (bottom) scores by category (L = low, M = medium, H = high, T = Total) compared with engagement categories;

	Affective engagement (n %)						Cognitive engagement (n %)							
	Low		Medium		High		Low		Medium		High		Total	
Q *L*	32	48.48	32	48.48	2	3.03	41	62.12	23	34.85	2	3.03	66	57.39
1*M*	14	66.67	5	23.81	2	9.52	15	71.43	4	19.05	2	9.52	21	18.26
H	12	42.86	16	57.14	0	0	21	75	6	21.43	1	3.57	28	24.35
Q *L*	14	53.85	10	38.46	2	7.69	17	65.38	8	30.77	1	3.85	26	22.61
2*M*	14	41.18	18	52.94	2	5.88	21	61.76	10	29.41	3	8.82	34	29.57
H	30	54.55	25	45.45	0	0	39	70.91	15	27.27	1	1.82	55	47.83
T	58	50.43	53	46.09	4	3.48	77	66.96	33	28.7	5	4.35	115	100

We also tested the relationship between individual engagement factors and performance score for different groups. For hint groups (Group 1 and 3), the chi-square test showed the significant difference between Peer Support at School (PSS) variable and quiz score 1 X2 (N = 62) = 12.84, p = 0.01 for hint groups. There are 26 students with low PSS category. 53.85% of them scored low quiz score for attempt 1. While for second attempt, there is improvement in scores for this category with 65.38% in high quiz score category.

For all groups, the chi-square test showed statistically significant different results for Peer Support at School (PSS) variable with the quiz score 1 X2 (N = 115) = 10.43, p = 0.03, demonstrating statistical differences between these two variables. For all groups that is mix of students with hints and no hints, there are 43 people with low PSS category and 58.14% scored low but for second scenario 53.49% scored high. As some of the students with low PSS score received hints, explains the reason of improvement for people with low PSS score as described for above relation.

On average participants answered 6.23 questions correct in second scenario as compared to 4.47 questions correct in the first scenario. All personality types showed an improvement after the first scenario. Most participants (67.82%) in all groups performed better for second scenario however the improvement for hint groups is more than the control groups.

Table 6 presents the summary data for participants who scored high in the quizzes and personality dimensions. We calculated chi-square test on personality and performance results. For all groups, chi-square tests reveal significant differences in performance (measured by the quiz) between participants with different levels of openness (X2 (N = 115) = 8.86, p = 0.06). The majority (56.52%) of participants scored high on the Openness personality dimension; just over half (50.7%) of these achieved a score of 4/10 or less in the quiz test, while 29.23% achieved a score of 7/10 or over. These high achievers represent 67.86% of the participants achieving a high score. No significant differences were found between Openness and the second quiz score. We note that the participants in the bottom 10% did not improve their score. So the hints or practice did not help. This is in contrast to the medium and high achieving categories, where for example, the percentage of low achievers with high Openness reduced to 20% (from 50.7%) after the second round.

Table 6. Participants in high personality categories with high quiz scores

Categories		Openness		Conscientious		Extroversion		Agreeableness		Neurotic	
Score 1	28	19	67.86%	12	42.86%	8	28.57%	10	35.71%	11	39.29%
Score 2	55	35	63.64%	22	40%	21	38.18%	23	41.82%	21	38.18%

5 Discussion

The goal of this study is to investigate the influence of personality and engagement (Cognitive and Affective) on the students' performance in an EVW. We also investigated whether gender, gaming hours, and providing hints influenced performance. In this paper, measurement of performance was restricted to the quiz scores achieved.

We did not include in our analyses any of the behavioural engagement data. In a previous study we captured navigation data, identified navigation path patterns and analysed navigation paths to identify their relationship to quiz score in order to derive suitable tips [20]. We used those patterns to provide tips that were used in the study presented in this paper. A forthcoming paper focuses on the relationship between scores, hints and navigation paths, but does not consider any other factors [21]. We have yet to combine the navigation data with the data presented in this paper. We also intend to look at performance as measured by time spent in the world. The goal of this body of work is to increase our understanding of the learner and their performance in EVWs, to gain insights for effective EVW learning design and how the EVW should adapt according to specific student features and needs.

The literature suggests a strong positive correlation between student engagement and student achievement [6, 15, 17, 18]. The results of this study (Table 5) show that some students with low engagement were able to achieve high scores, and overall 57.39% of students (61.12% with low cognitive engagement compared to 48.48% with low affective engagement) achieved a low score in the first quiz, and more than half of these students were able to improve their score after using the EVW a second time. This is probably because students were unfamiliar with the EVW and what was expected of them, but in the second round they applied the knowledge and experience gained from the first round. This was true regardless of whether they were in the hints or control group. In answer to the first research question, we cannot, in general, confirm a relationship between levels of engagement and performance, although our results show some evidence of relationships of individual engagement categories (i.e. peer support at school (PSS) and intrinsic motivation (IM)) with performance.

Consistent with the literature, the results do confirm a positive relationship between affective engagement with cognitive engagement. The students who are highly engaged in affective manner are also engaged cognitively as well and vice versa. This result is supported by same pattern for control groups and hint groups as well with statistical significant results. While the differences are not significant, our results show evidence that students with high cognitive engagement improved more as compared to low cognitively engaged students in their second scenario.

Regarding the influence of personality, our cohort had a majority of people with high Openness personality dimension and most of this category attained high score for scenario 1. Low achievers with high Openness performed better in their second attempt. This supports the argument that people with open personalities are more creative and curious. They tend to perform better in subsequent tasks with their creative ideas. Our results indicated positive relationship between openness to experience and performance, consistent with other relevant study [14]. It appears that they learnt from their experience from using the EVW for the first time. This improvement was true whether participants received hints or not.

Participants who are more organized have higher level of affective and cognitive engagement as compared to disorganized individuals (with low conscientiousness personality trait). This suggests that organized people are more engaged. Given that, being organised is one of the attribute of conscientiousness and it is often used to

describe hard working and high achieving students, it is not surprising that there is a connection between the conscientious personality trait and engagement levels. From the results it is apparent that the personal trait of being organised and conscientiousness is related positively to the cognitive engagement.

Related to our second research questions concerning the usefulness of hints for different individuals, the performance of participants in the low peer support at school (PSS) category improved for hint groups in the second round. These findings may indicate that providing hints to the people with low PSS was useful. This supports the argument that peer support encourages social and emotional learning, positive psychology among students and helps in learning [22]. Except for this finding, our analysis of the five personality dimensions with the second quiz score did not reveal any significant differences, regardless of group and whether they received hints or not. Thus, we don't have any clear evidence to suggest that different personality types benefit more from hints or help than others. The participants that were in the hint group in general did not do significantly better than those in the control group. Larger sample size and different populations might show different results. Also, since our results suggest that scenario 1 was harder than scenario 2 and receiving scenario 1 first provided a greater learning opportunity than scenario 2, a future study should balance the difficulty of two scenarios better (we had intended them to be equally difficult). In line with productive failure [23] and impasse learning [24], the implication of our results is that we should provide a challenge to students at the start, rather than a highly structured or guided task. Our study suggests that all participants might benefit from providing all the hints after using the EVW once. Further studies are needed to confirm the importance of tailoring hints, though intuitively and also supported by impasse learning concepts, offering help before it is needed is usually unwanted and unhelpful.

Besides answers to our research questions, there are some interested findings in this study that are worth mentioning. More specifically, this research found that students who play games achieved lower quiz scores. These findings suggest that previous gaming experience does not help students to perform well in virtual environments rather it affects their performance negatively. It is not suggested that participants have a better performance when they have more experience with games compared to others. Another study is necessary to confirm the link between gaming hours and performance. The results suggested that there is no direct relation between gaming hours and performance in terms of number of correct answers. Another finding from this study was that people who do not play games are more cognitively engaged. This suggests that participants who do not play games can be more attentive and emotionally aware hence more cognitively engaged.

No gender specific differences were observed in this study from performance perspective as quiz scores did not show any significant differences. However the results revealed that females are (or perceive themselves to be) more agreeable than males, or conversely that males are more likely than females to sometimes describe themselves as disagreeable. This may reflect cultural norms where it may be more acceptable for males to argue and analysis of gender differences showing that females tend to be more cooperative and agreeable [25].

6 Conclusion and Future Work

Towards creation of more intelligent EVWs, we sought to understand the possible influences of individual differences of the learner (such as personality, cognitive and affective engagement) on their performance and behaviours. Deeper and accurate understanding of learner features and behaviours in EVWs can facilitate better artificially intelligent technologies to improve the learning effectiveness of EVWs. Our study found some differences in performance depending on personality, engagement level, gender and a few other factors. These factors were captured outside the EVW. In the future we intend to capture this information and pass it to the EVW so that it might adapt appropriately using the rules uncovered from our current experimental datasets.

Further research with larger cohorts and other non-psychology students would strengthen the generality of the results. The findings of this study stress the significance of understanding the learner better in order to design more efficient virtual learning platforms. As future work, school student population can be included for further examination of links studied in this study. New research could be based on these findings as to specify more clearly what helps to improve performance via EVW and in what way help can be provided to students depending on their personality traits to improve their performance.

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