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HIGHER ARTS AND DESIGN STUDENTS' ATTITUDES TOWARDS LEARNING COMPUTER PROGRAMMING

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Abstract

A review of undergraduate arts and design programmes offered in Portuguese public higher education revealed some form of computer programming is included in about half of the curricula. This paper aims to address a gap in scholarship about arts and design students' acceptance of programming. A study was conducted which applied a survey instrument based on the Unified Theory of Acceptance and Use of Technology to a sample of students enrolled in those arts and design programmes that include computer programming units. Out of 270 valid responses, 44.8% of students reported to be already familiar with computer programming and 28.5% reported to be currently learning. Their level of familiarity was found to correlate with students' views of the utility, effort, peer approval, self-efficacy and anxiety associated with programming. Among students familiar with programming or currently learning, it was also found those perceiving the activity as voluntary were more likely to harbour a positive perception of its utility and effortlessness, while reporting less anxiety. Positive perceptions of utility, effortlessness and peer approval were also found to correlate with students' intention to program or to learn computer programming, while higher anxiety had a strong negative impact on that intention. Female students, comprising 57% of participants, were more likely to see with greater anxiety the perspective of programming computers. Students' anxiety is therefore a challenge for educators, and efforts to demystify the topic and to mitigate differences between genders in programming acceptance should be encouraged. Given the present prevalence of computer programming in arts and design curricula, scholars are also encouraged to conduct further research, including case-studies and wider technology acceptance surveys.

Keywords: *Higher education, arts education, technology acceptance, computer programming, student survey.*

1. Introduction

There were approximately 15500 students enrolled in 105 undergraduate arts and design programmes in Portugal's public higher education institutions during the academic year 2016-2017, according to data published by the Portuguese Ministry of Science, Technology and Higher Education (DGEEC, 2017). Those programmes include a wide range of specialities, such as visual arts, music and other performing arts, multimedia, communication design, product design, or architecture. Examination of each programme's curricula allowed the researchers to identify 43 programmes that include one or more mandatory units on the topic of computer programming, as well as 7 programmes including elective units on the subject. Overall, it was determined that approximately 7650 arts and design students enrolled in public higher education will have the opportunity to learn computer programming while taking their undergraduate degrees, and that 6400 of those students will indeed be required to complete at least one mandatory unit on the subject. Still, there is little research on these students' opinions and attitudes regarding computer programming. This paper thus presents the main findings from a study on computer programming acceptance by arts and design undergraduate students, which follows up on a preliminary survey by the researchers (Morais, Morais, & Paiva, 2018a).

In the Unified Theory of Acceptance and Use of Technology (UTAUT) technology use is understood as the dependent variable, which in turn is predicted by Behavioural Intention, a view shared by multiple technology acceptance models (Venkatesh, Morris, Davis, & Davis, 2003). In formulating UTAUT, its authors reviewed multiple such models and hypothesized three constructs – Performance Expectancy, Effort Expectancy, and Social Influence – as determinants of Behavioural Intention to use a technology, while hypothesizing an additional construct – Facilitating Conditions – as a direct determinant of actual use. In UTAUT, Performance Expectancy is defined as the degree to which users

perceive a technology as useful for achieving their goals; Effort Expectancy as users' perception of ease of use and learning; Social Influence as users' view of other people's expectations towards their use of that technology; and Facilitating Conditions as users' belief their technological and organizational environment supports using that technology. Venkatesh et al. also tested three other constructs – users' own Attitude Towards Use, users' Anxiety about the technology, and users' perception of Self-Efficacy in using the technology – and didn't find them determinant of either Behavioural Intention or actual technology use. In addition, UTAUT also proposes that the relationships between constructs and dependent variables are moderated by users' age, gender, experience, and the degree to which they feel their use of a technology is voluntary.

According to the original paper, UTAUT explains approximately 70% of the variance in Behavioural Intention and 50% of the variance in technology use when the moderating variables are included in the analysis (Venkatesh et al., 2003). Recent literature reviews corroborate the adequacy and the widespread use of the model in educational technology research (Khechine, Ndjambou, & Lakhal, 2016; Williams, Rana, & Dwivedi, 2015), while also demonstrating the application of UTAUT to a wide spectrum of technologies. UTAUT was therefore considered an appropriate model for studying arts and design students' acceptance and use of computer programming.

2. Methodology

The present study applied an online survey instrument based on the Unified Theory of Technology Acceptance and Use to an opportunity sample of students enrolled in Portuguese public arts and design undergraduate programmes where computer programming is included in their curricula. The researchers devised a survey including items measuring Performance Expectancy, Effort Expectancy, Attitude Towards Use, Social Influence, Facilitating Conditions, Self-Efficacy, Anxiety, and Behavioural Intention (Venkatesh et al., 2003) as seven-point Likert scales in disagree-agree format. Recent research has revised some of the hypotheses in Venkatesh's original UTAUT paper and validated Attitude Towards Use as a direct determinant of Behavioural Intention (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2017). In addition, given the topic of computer programming, a measure of students' Self-Efficacy and Anxiety towards that activity was considered very valuable on its own.

Moderating variables in the UTAUT model, such as gender and age, were collected through demographic characterization questions. Experience was presented as a ternary option between no knowledge of programming, currently learning, previous familiarity. Perceived voluntariness of use followed the original authors' use of a single seven-point scale from fully mandatory to fully voluntary (Venkatesh et al., 2003). Participants with some experience of computer programming were also asked to self-report their usage frequency and intensity, following the scales proposed by Davis (Davis, 1986). The questionnaire was written in Portuguese and validated by a focus group of students and by retroversion by an independent professional translator and subsequent comparison to the original items.

2.1. Data collection

The researchers contacted the academic coordinators for the 50 arts and design programmes previously identified and asked them to forward the survey, which had been prepared as a Google Form. Responses were collected during two periods, March to April and September to October 2018, as not all recipients responded and forwarded the survey to students at the same time. On aggregate, 344 responses were obtained from students in 18 different institutions. After excluding responses from students attending programmes outside the scope of this study, a sample of 270 valid questionnaires was obtained.

2.2. Data analysis

The SPSS 24 software was used for analysis of the valid questionnaires. Item groups corresponding to the UTAUT constructs were analyzed for internal reliability. Responses were grouped by participants' knowledge of computer programming, as students that reported no knowledge of the topic had received some of the questions in slightly different form. In any case, Performance Expectancy, Effort Expectancy, Attitude Towards Use, Facilitating Conditions, Self-Efficacy, Anxiety, and Behavioral Intention were all found to have an adequate or better level of reliability (Cronbach's $\alpha > .7$), as defined by Nunnally (1978). Factor analysis also corroborated these constructs' consistency. However, Social Influence was revealed to factor into two components among students without knowledge of programming and among those learning for the first time. Two Social Influence items related to institutional support of programming, which presumably made little sense to those students, were removed. The remaining two items were found to have excellent reliability ($\alpha > .8$) and are equivalent to the items composing the Subjective Norm construct from the Theory of Planned Behaviour, which is defined as the influence of peers and people the individual regards as important (Ajzen, 1991) and was included in the UTAUT model.

3. Results

Out of 270 participants, 121 students (44.8%) reported familiarity with some form of computer programming, 77 (28.5%) reported to be learning for the first time, and the remaining 72 (26.7%) reported no knowledge of the topic. 217 students (80.4%) have or will learn computer programming while taking their degree, while the remaining, presumably enrolled in a programme where programming is elective, reported choosing not to. Table 1 presents participants' gender, age, and the programme year they were attending, broken by students' reported experience. For clarity, age and seniority are presented as groups, even though their values were collected and analysed as continuous integers. Please note that most undergraduate arts and design programmes in Portugal are three years long.

Table 1. Demographic characteristics of the students and their level of programming experience.

		No knowledge (n = 72)		Learning (n = 77)		Prior knowledge (n = 121)		Total (n = 270)
		n	%	n	%	n	%	n
Gender	Female	46	29.9%	51	33.1%	57	37.0%	154
	Male	26	22.4%	26	22.4%	64	55.2%	116
Age	18 – 20	35	25.5%	51	37.2%	51	37.2%	137
	21 – 24	29	28.7%	19	18.8%	53	52.5%	101
	25 – 34	6	25.0%	5	20.8%	13	54.2%	24
	35 +	2	25.0%	2	25.0%	4	50.0%	8
Year (Seniority)	1st year	20	27.0%	34	45.9%	20	27.0%	74
	2nd year	21	29.6%	19	26.9%	31	43.7%	71
	3rd year	22	23.7%	21	22.6%	50	53.8%	93
	4th year +	9	28.1%	3	9.4%	20	62.5%	32

Students were also asked to report their daily computer use, and strong Spearman 2-tailed correlations were found between greater daily computer use and knowledge of programming ($p < .001$). Neither gender, age, or seniority were found to correlate with students' level of programming knowledge.

3.1. Acceptance and use factors

Computed means and standard deviations for each UTAUT construct are presented in Table 2, broken by students' programming experience. Since the original scales ran from -3 (full disagreement) to 3 (full agreement), a positive Performance Expectancy reflects an agreement with programming being useful, while a positive Anxiety reflects an agreement with programming being intimidating.

Table 2. UTAUT constructs' mean responses and students' programming experience.

	No knowledge (n = 72)		Learning (n = 77)		Prior knowledge (n = 121)	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Performance Expectancy	0.15	1.43	0.68	1.43	1.07	1.43
Effort Expectancy	-0.95	1.24	-0.69	1.21	0.10	1.48
Attitude Towards Use	-0.35	1.64	0.25	1.59	0.91	1.74
Social Influence	-	-	-	-	0.22	1.51
(Subjective Norm)	-1.49	1.52	-0.55	1.57	0.06	1.73
Facilitating Conditions	-0.62	1.29	0.16	1.56	0.72	1.50
Self-Efficacy	-0.80	1.17	0.26	1.31	0.75	1.27
Anxiety	-0.22	1.47	0.13	1.28	-0.58	1.52
Behavioral Intention	-1.99	1.21	-0.08	2.04	0.25	2.11

Analysis found compelling Spearman 2-tailed positive correlations between students' knowledge of programming and their Performance Expectancy, Effort Expectancy, Attitude Towards its Use, their influence by Subjective Norm, their regard of the Facilitating Conditions, and sense of Self-Efficacy (all p values $< .001$). A suggestive correlation between more programming knowledge and less Anxiety was also found ($p = .027$), however it was students that were learning to program that reported the highest Anxiety. Behavioural Intention to use or learn programming also correlated very strongly with students' knowledge ($p < .001$). Students without that knowledge were very likely to report having no intention to learn or use it in the future. Note that 53 participants in the survey, presumably taking degrees where the subject is elective, had reported no plans of learning to program while taking their degree.

Application of the appropriate analyses while grouping responses by participants' programming knowledge yielded correlations worth noting, which are detailed in the following three sections.

3.1.1. Students without any knowledge of programming. Among students without any knowledge of programming, analysis found a persuasive Pearson 2-tailed correlation in which older students were more likely to report less Anxiety towards programming ($p = .008$). However, strong negative correlations were found between students' seniority and both their influence by Subjective Norm ($p < .001$) and their Behavioural Intention ($p = .002$). Regardless of age, students closer to finishing their degree, presumably with their interests consolidated, were thus more likely to feel less peer pressure regarding learning programming and to have a lesser inclination to do it.

Spearman 2-tailed analysis yielded a positive correlation between students' time spent daily using a computer and their Performance Expectancy of computer programming ($p = .001$). Persuasive correlations between students' gender and some UTAUT constructs were also found. Female students were more likely to regard learning and using programming with greater Anxiety ($p = .006$), while male students reported more positive views of the Facilitating Conditions ($p = .006$).

3.1.2. Students currently learning programming for the first time. Among students learning to program for the first time, Spearman 2-tailed analysis found significant correlations between their gender and their acceptance of computer programming. Male learners were much more likely to harbour better Effort Expectancy ($p = .005$) and Attitude Towards Use of programming ($p = .001$), as well as a better view of the Facilitating Conditions ($p = .009$). Male students were also somewhat more likely to report a better Performance Expectancy ($p = .020$) and Self-Efficacy ($p = 0.20$). A conclusive correlation showed female students were again more likely to regard programming with greater Anxiety ($p = .002$) and in addition were also somewhat less likely to manifest a Behavioural Intention to program in the future ($p = .029$).

Students learning programming were asked to report on their perceived voluntariness of programming use and compelling correlations were found between greater voluntariness and better Performance Expectancy, Effort Expectancy, Attitude Towards Use, as well as less Anxiety (all $p \leq .001$). Greater perceived voluntariness also showed a very strong correlation with a greater Behavioural Intention to program ($p = .001$).

3.1.3. Students already familiar with programming. Among students that reported prior knowledge of computer programming, Spearman 2-tailed analyses also yielded significant correlations between their gender and their computer programming acceptance. Male students were more likely to report better Performance Expectancy ($p = .012$), Effort Expectancy ($p = .002$) and Attitude Towards Use of programming ($p = .004$), a better view of the Facilitating Conditions ($p = .003$) and of their Self-Efficacy ($p = .005$). Yet again, a strong correlation was found showing that female learners were more likely to view programming with greater Anxiety ($p < .001$) and were much less likely to manifest a Behavioural Intention to program in the future ($p = .002$).

These students also reported on their perceived voluntariness, and strong correlations were found between reporting a greater voluntariness and reporting better Performance Expectancy ($p = .016$), Effort Expectancy ($p < .001$), and Attitude Towards Use ($p < .001$), less Anxiety ($p = .005$), and greater Self-Efficacy ($p = .019$). Greater perceived voluntariness also showed a very strong correlation with a greater Behavioural Intention to program ($p = .002$).

3.1.4. Students' Behavioural Intention to use or learn computer programming. As expected from UTAUT, Spearman 2-tailed correlations were found between participants' responses to the other constructs and their Behavioural Intention. Positive views regarding Performance Expectancy, Effort Expectancy, Attitude Towards Use of programming, and Subjective Norm all showed compelling correlations to students' Behavioural Intention to use or learn programming ($p < .001$). Overall Social Influence also showed a compelling positive correlation to Behavioural Intention among those students already knowledgeable of programming ($p < .001$). While not explicitly predicted by the model, very strong correlations between a positive view of Facilitating Conditions and Behavioural Intention to use computer programming were also found among students learning and among students with knowledge of computer programming ($p \leq .002$). Self-Efficacy also correlated compellingly with Behavioural Intention among students in those two groups ($p \leq .001$); the same correlation was also found among students without any familiarity with programming, but not as strongly ($p = .018$). It is also worth emphasizing that Anxiety showed a compelling negative correlation with Behavioural Intention to use computer programming among learners ($p < .001$), as well as a persuasive negative correlation with the Behavioural Intention to learn among students unfamiliar with the topic ($p = .006$).

As described, students that were learning or already familiar with computer programming were also asked to report on their frequency and intensity of use. Behavioural Intention to use computer programming correlated compellingly with frequency and intensity of use among these students ($p < .001$ in all cases), thus corroborating one of the core assumptions of the UTAUT model.

4. Discussion and conclusions

Both the preliminary study (Morais et al., 2018a) as well as the present one show that even in the congenial context of arts and design undergraduate education, gender remains, alongside prior familiarity, the greatest factor in students' attitudes and opinions about computer programming. This is all more important as 'learning to code' is so often considered an element of digital literacy (KnowledgeWorks, 2015), which in turn is one of the arguments for the dissemination of computer programming in arts and design education (Knochel & Patton, 2015). Given the consistent differences that were found in expectations of effort, attitude, and feelings of anxiety regarding computer programming between male and female students involved with the subject, addressing these should be a concern of educators adapting programming syllabi to arts and design education. These conclusions run convergent with those of a survey of art and design educators' views of computer programming (Morais, Morais, & Paiva, 2018b).

Continued interrogation of the UTAUT model would also be a worthwhile endeavour, and a context-specific model may be required given the width and the depth of computer programming as a base technology. Further analysis and validation of the model will be forthcoming. These findings can also further research on attitudes towards computer programming in arts and design education, both through larger technology acceptance studies and through practice characterization case-studies.

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