The role of student and instructor VARK learning styles in principles of economics

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Do students have preferred learning styles and, if so, can these preferences - in addition to other abilities and attributes - influence their performance in post-secondary education? There is a significant body of literature, across many disciplines, endeavouring to answer this question. In this paper, we examine a variant of this question with respect to the discipline of economics: to what extent do instructors' attributes and preferred learning styles also influence student performance in principles of economics courses? Employing the VARK (visual, aural, reading/writing, and kinesthetic) learning style preference methodology, we find evidence that student performance can be significantly influenced by (i) students who have a visual learning preference and (ii) instructors who share a preferred kinesthetic learning style with their students.

Introduction

Students' academic performance in post-secondary education can be attributed to a number of factors. Everything from previous academic performance in high school, to motivation, to whether a student is the first generation in their family to attend university, can influence an individual student's performance; the list is extensive, with many variables difficult to measure.

In the discipline of economics, there has been an evolution in terms of these explanatory variables. In more recent years, the relatively easy-to-measure, traditional reasons such as high school marks in mathematics and English, student gender and race, have been supplemented with more innate attributes such as expectations/attitudes (Ballard & Johnson 2005; Arnold & Rowaan 2014; Hodges, Durham & Henson 2018), learning styles (Brooks & Khandker 2013; Leung et al. 2014; Brunton 2015; Zhang 2017), and personality traits (Borg & Shapiro 1996; Zigert 2000; Opstad & Fallan 2010). Proxies for these intrinsic attributes include Myers-Briggs personality tests, Keirsey-Bates temperament sorter questionnaires, the VARK (visual, aural, reading/writing, and kinesthetic) inventory as well as analytical versus global learning styles.

Not surprisingly, different measurements for these innate attributes can lead to different conclusions with respect to the significance of these variables in determining student performance in economics. Most of these studies focus on individual students' attributes, although there are a number of studies examining the role of instructor attributes (Charkins, O'Toole & Wetzel 1985; Borg & Shapiro 1996; Brooks & Khandker 2013; Örtenbald, Koris & Pihlak 2017). There does not appear, however, to be any studies investigating cases where student-instructor VARK learning styles match. Understanding how instructors' abilities and attributes can influence student performance is an important question. The answer(s) can guide instructors in terms of what types of activities – both outside and inside the classroom – are most likely to

facilitate student learning. This paper contributes to the literature by investigating the link between student performance in principles of economics courses and instructors' attributes, with a focus on identifying the importance of student-instructor VARK learning style congruence.

Review of literature

The common use of graphical analysis in the teaching of economics has been shown to favour students with a visual learning style preference (Boatman, Courtney & Lee 2008; Sabiston, Leung & Terrazzano, 2017). Students with other preferred learning styles, however, may benefit from more diverse teaching styles in a typical economics classroom dominated by the traditional "chalk and talk" lecture approach (Becker & Watts 2001; Ongeri 2017). For example, Wright and Stokes (2015) suggested that the VARK (visual, aural, reading, and kinesthetic) inventory for learning style preferences is useful for designing course activities which, in turn, can help improve student learning and achievement in economics. Zhang (2017) argued that the incorporation of VARK methodology into teaching economics can help student learning - from both an efficiency as well as an equity perspective. Brunton (2015) emphasised the importance of using a diversity of teaching methods to motivate students with different learning styles in principles of microeconomics.

In identifying factors that can improve student motivation and performance in economics courses, the literature explores instructor-student match (congruence) in terms of personality, teaching style and learning style. Evidence from various studies shows mixed results on course performance in relation to personality match between instructors and students (Örtenbald, Koris & Philak, 2017). While Borg and Shapiro (1996) showed that instructor-student personality match improves student learning in principles of economics courses, other studies fail to confirm this relationship (Zigert 2000; Örtenbald, Koris & Philak, 2017). An early study by Charkins, O'Toole and Wetzel (1985) identified three types of student learning styles (dependent, collaborative, and independent) and found that matching an instructor's teaching style with a student's learning style increases the student's performance. Terregrossa, Englander and Wang (2009) also concluded that congruency between instructors' teaching styles and students' learning styles can systematically influence student achievement in principles of economics courses.

Brooks and Khandker (2013) provided one of the more elaborate studies on how student performance in economic principles courses is related to matching learning style preferences. With a sample of 327 students and five instructors, the authors used a 20-question survey. The survey's goal is to distinguish a preference for an analytical learning style (left-brain functions) versus a preference for a global learning style (right-brain functions). Evidence from their study showed no significant relationship between student performance in principles of microeconomics and instructor-student learning style congruence. The authors concluded that other factors such as students' effort and ability are more closely related to student performance. Moreover, they suggested "that the case for matching students to instructors in order to improve student learning is tentative at

best, and at worst it is a large drain on resources" (p. 240). Other recent studies (Brunton 2015; Hodges, Durham & Henson 2018) reiterated this position; namely that there is no need to spend resources on designing instructional methods geared to different learning styles when there is no significant relationship between learning style preferences of students and their performance in principles of economics courses.

There are, however, limitations to these studies. Most studies use personality measures such as the Myers-Briggs Type Indicator as a proxy for learning style. Other studies use thinking style measures that might not be ideal for examining learning style issues in economics education. A typical economic principles course, for example, emphasises the logical presentation of ideas, relying heavily on graphical representations (Leung et al. 2014). Hemispheric preference surveys (Brooks & Khandker 2013), however, do not create thinking style preferences that necessarily align with learning in economics. Statements such as "I like teaching or explaining by visual presentations" and "I am logical" are presented in the hemispheric preference survey as evidence of different thinking styles, yet both statements represent *one* thinking style consistent with how economics is traditionally taught. The VARK learning style inventory appears to be a more precise measure that aligns better with the economics way of thinking. Studies in economics that use the VARK methodology, for example, tend to provide consistent findings on the positive relationship between the visual learning style preference and student performance as mentioned previously. Even studies that fail to observe a statistically significant relationship recognise that the four learning styles in VARK together explain a significant proportion of variation in student performance. For example, Hodges, Durham and Henson (2018) reported that the four learning styles of VARK explain more than 20% of variation in the course grade of students in microeconomics principles, even though none of the four learning styles show an individual significance on course performance.

In summary, the debate in the literature is far from conclusive, particularly with respect to the relationship between student performance and the role of instructor and student learning style preferences. In the discipline of economics, however, the VARK learning style pedagogy appears to be a better instrument to capture learning style preferences.

Research questions

1. Do student and instructors have preferred VARK learning styles?
2. What student and instructor attributes explain students' performance in principles of economics courses?
3. Does student performance in principles of economics courses improve when students and instructors share identical VARK learning style preferences?

Method

Participants

The data for this study was gathered from students enrolled in *Principles of Microeconomics* (7 sections) and *Principles of Macroeconomics* (6 sections) along with their instructors at Mount Royal University (MRU) in Calgary, Canada. All first-year economics courses at MRU are capped at 35 students and are taught in the traditional three-hour per week lecture format with most sections offered twice a week at 90 minutes per session. From a potential of roughly 450 students, 217 elected to participate in this study and were asked to fill out a questionnaire consisting of two sections.

Procedure

Instructors and students in their classes were recruited to participate in the survey. Each participant was provided informed consent before proceeding with the survey, which took about 10 minutes to complete in the classroom. All methods and procedures have been approved by the Human Research Ethics Board (HREB) at Mount Royal University.

Questionnaire measures

The first section of the questionnaire contained five questions identifying both abilities and attributes considered to influence students' performance in first-year economics courses: age, gender, high school grades in mathematics (Math 30) and language/arts (LA 30), as well as the number of hours of paid work. Each of these variables, to a certain degree, was expected to influence a student's final grade. The rationales for these choices, along with their anticipated signs, are provided in the empirical models and findings section. Final grades – measured as a percentage – are used to identify students' performances in these courses. With the exception of those students who participated but later withdrew from the course (W), all grades are recorded, including those students who failed.

The second section of the questionnaire identified the student's VARK-based preferred style of learning. The data from this section is based on version 7.1 of the VARK questionnaire developed by Fleming and Mills (1992) and comprises sixteen multiple choice questions. Although every question has four potential answers – each answer implying a specific preference for one of the four learning styles – participants are asked to choose *all* answers in each question that are relevant to them. By selecting all relevant answers for each question, we can identify students with bimodal or multimodal learning styles. Raw scores for each of the learning styles (i.e., V, A, R and K) can range from 0 to 16 for each participant. Fleming (1995) suggests, however, that a strong preference for a particular learning style occurs when an individual learning style's raw score *is at least four points higher* than a raw score of any other learning style. As such, the raw scores for V, A, R and K are recoded in a binary form; a value of 1 indicates a strong preference for a specific learning style, otherwise the value is 0.

According to the most recent data collected in 2020 by VARK Learn Limited (Vark Learn Limited, n.d.), approximately 74% of over 200,000 VARK survey participants agreed that their learning preference results matched their own perception of how they learn; 23% said they were not sure, and only 3% thought it did not match. In addition, kinesthetic (K) is reported as the most common preference and visual (V) the least common preference.

Descriptive statistics and VARK analysis

Students' descriptive statistics

Table 1 provides descriptive statistics of the variables identifying abilities, attributes, and final grades.

Table 1: Descriptive statistics - students

	Age	Math 30	LA 30	Hours of work	Grade (%)
Mean	20.6	77.98	77.20	11.45	70.19
Minimum	17	52	60	0	25.4
Maximum	41	98	97	50	98.6
No. of students	212	204	208	217	215 (2W's)

The average age of 20.6 years for first-year principles of economics courses reflects MRU's historical trend of attracting older students, relative to primarily research-orientated post-secondary institutions. The average high school grades in mathematics and language/arts are in the high 70s and students work, on average, over 11 hours per week.

Student VARK analysis

Once the raw VARK data are converted to a binary form, we can identify students' preferences for certain learning styles ranging from "no preference" up to a "trimodal" configuration.

From Figure 1, we notice that 45% (97/217) of the participants do not identify a dominant learning style(s). This does not necessarily mean these students do not have a preference for one learning style over another. By definition, it simply captures the fact that no one raw score of an individual learning style is at least four points higher than a raw score of any other learning style. It's quite possible that, over the years, these students have developed, to some degree of competence, each of the four VARK learning styles without specifically relying on one (or more) learning styles to help understand new concepts or ideas.

The remaining 55% of the participants (120/217) have one or more preferred learning styles, although in the case of a trimodal preference, it is probably more apt to think of these students as having a deficiency in the remaining learning style rather than a strength,

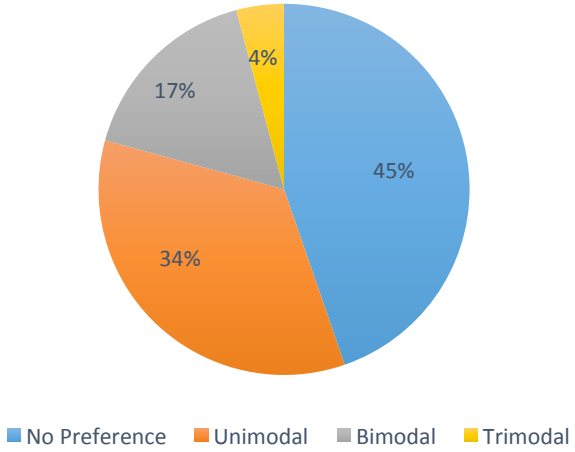

Figure 1: Students' VARK learning styles

in three. A student with an aural, read/write, and kinesthetic (ARK) trimodal preference for example, has relatively low raw scores in the visual category (V). This type of preference is representative of students who have difficulties interpreting new information in the form of graphs, charts, diagrams and other visual images. Figure 2 looks at the total number of students who have identified each of the four learning styles as a preferred learning style.

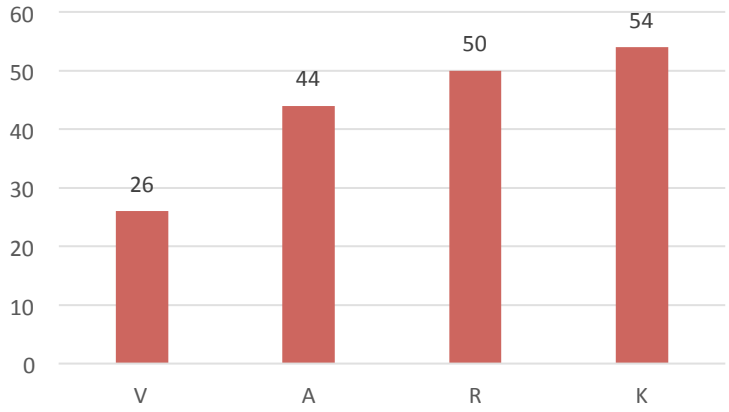

Figure 2: VARK learning styles - total

Figure 2 indicates that the highest number of students (54) identified kinesthetic as a preferred learning style, followed by read/write (50), aural (44), and visual (26). Figures 3, 4 and 5 provide binary VARK data for students with unimodal, bimodal, and trimodal learning style preferences.

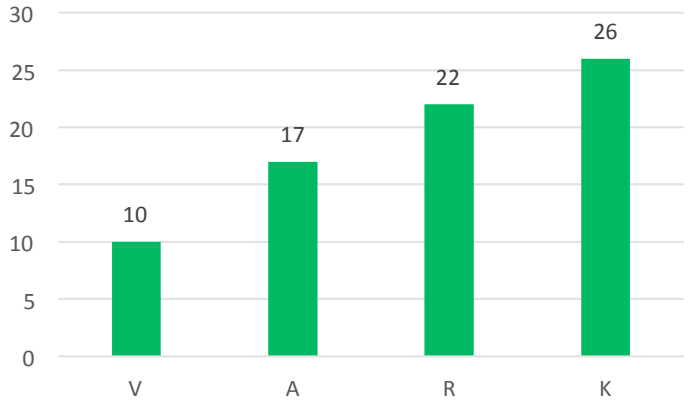

Figure 3: VARK learning styles - unimodal

Of the 75 participants identified as unimodal, Figure 3 indicates that over a third were kinesthetic (26/75 = 35%), followed by read/write (29%), aural (23%), and visual (13%). Note that we can divide the values in Figure 3 by their corresponding values in Figure 2 to identify the percentage of each learning style that is exclusively unimodal. For example, we see that 48% (26/54) of the students who have a kinesthetic preference are unimodal kinesthetic learners. This is the highest percentage of the four learning styles as read/write is 44% (22/50) and both visual and aural are roughly 38.5% each.

Of the 36 bimodal learners, Figure 4 illustrates that the highest number are a combination of aural + read/write (AR). When we examine and compare the individual learning styles within each combination, we see that the largest percentage have a read/write (R) component (21/36 = 58.3%). There is a tie between aural (A) and kinesthetic (K) learners at 55% (20/36) for the second largest percentage and visual learners only account for 33% (12/36) of the bimodal participants.

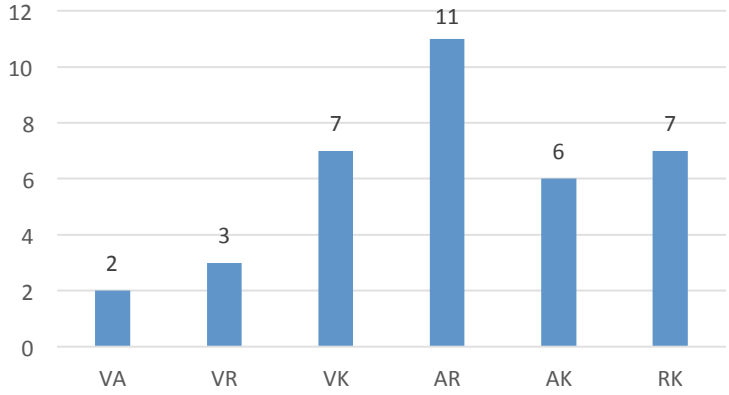

Figure 4: VARK learning styles - bimodal

There are only 9 students who identify as trimodal learners and Figure 5 shows that roughly 56% (5/9) are a combination of aural + read/write + kinesthetic (ARK). Once again, when we examine and compare the individual learning styles within each trimodal combination we observe a similar pattern to bimodal learners. Read/write (R), aural (A) and kinesthetic (K) are the more important individual learning preferences whereas visual (V) is the least representative learning style.

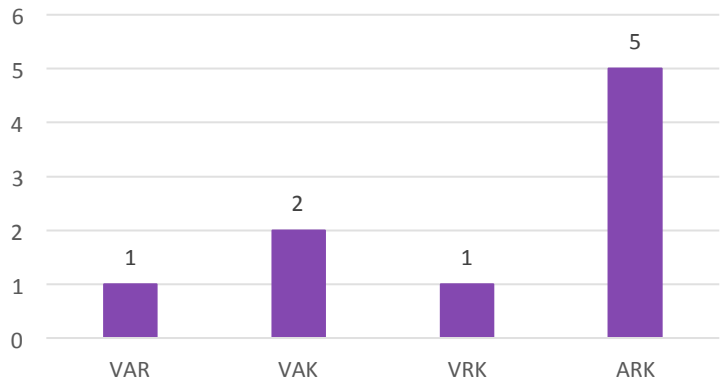

Figure 5: VARK learning styles - trimodal

Instructor Information

There were eight instructors teaching the combined 13 sections of the Principles of Microeconomics and Principle of Macroeconomics courses. Diversity in the classroom is a strength at Mount Royal and collectively, these instructors have a variety of university teaching experience, ranging from two years to twenty years, across all discipline fields, and from freshmen to seniors.

Instructors' descriptive statistics

A detailed discussion about attributes, unfortunately, can identify individual instructors. To avoid this problem, we need to find a way to aggregate the attributes in some manner but still retain important information. Given that a significant proportion of the students (44%) are taught by female instructors, Table 2 presents some of the instructors' information along the lines of gender.

Table 2: Descriptive statistics - instructors

	Number of instructors	Number of students taught	Contract faculty	Average final grade	Sections of macro	Sections of micro
Male	5	121	1	67.2%	6	2
Female	3	96	3	73.4%	0	5

Full-time instructors (tenured and tenure-track) represent half the instructors and 100 of the 217 participants are registered in their sections. Of the remaining four contract faculty, three are female and all teach Principles of Microeconomics sections. Finally, we see that the average final grades for female instructors are roughly 6% higher than their male colleagues. It should be noted, however, that one of the three female's average final grade is below the average male final grade of 67.2%.

Instructor VARK analysis

During the semester, each of the instructors also completed the VARK questionnaire developed by Fleming and Mills (1992). Results in Figure 6 show that 25% of instructors (2/8) do not have any preferred learning style and the remaining six all have unique preferences. Of these six, two are unimodal, three are bimodal, and one is trimodal. Interestingly, there are no unimodal kinesthetic (K) instructors, but all of the multimodal instructors include a preference for kinesthetic learning.

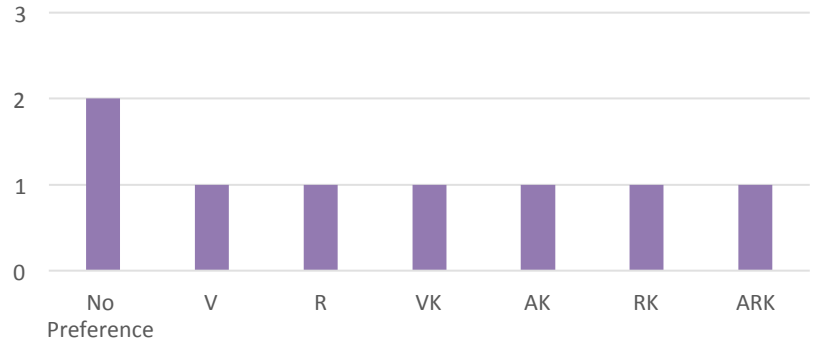

Figure 6: Instructors' VARK learning styles

Summarising some important results of these descriptive statistics we see that:

(i) for students,
- over 50% have some form of preferred VARK learning style of which the largest category is unimodal.
- of these unimodal cases, most students are kinesthetic (K) whereas visual (V) is the least representative learning style.
- in bimodal and multimodal cases, we see a similar pattern whereby kinesthetic (K) is a more important individual learning preference and visual (V) is the least representative.

(ii) for instructors,
- over 75% have some form of preferred VARK learning style of which the largest category is bimodal.
- of two unimodal cases, neither is a kinesthetic (K) learning style.

- in bimodal and multimodal cases, all instructors have an element of kinesthetic (K) in their learning preferences.

VARK analysis discussion

From this summary, there are two points in particular that merit additional discussion. Firstly, we see that the kinesthetic (K) learning style is important for both students and instructors. For students, many are unimodal kinesthetic learners but for instructors this learning style is always accompanied by at least one other VARK learning style. While beyond the scope of this paper, it would be interesting to know at what stage these instructors developed their preference for kinesthetic learning styles – did they come into the discipline with a kinesthetic preference and realise that they needed other learning styles to master economic concepts and earn a post-graduate degree? Or did they have other learning styles but recognised – as instructors – that they needed to adopt a kinesthetic approach to teaching?

The second point of interest centres around the visual (V) learning preference. With graphs and tables as a preferred method of explaining economic concepts in the principles of economics courses, the discipline is highly "visual" in nature. As mentioned in the literature review, this explains why a number of VARK studies show a significant positive relationship between visual learners (V) and student performance. In our data, however, we see that visual (V) learners represent the *lowest* of the VARK inventory. This might explain the low average grade in our discipline at the introductory level (C+/B-). But a more relevant question would be: why are there so few students with visual preferences enrolled in our principles courses? Should our discipline not be attracting visual learners? The answers to these questions lie in the composition of our students at the introductory level. Students enrolled in principles of economics courses major in a range of disciplines – from pure sciences (chemistry, physics, biology) to the finest of arts (music, art history). These students typically take economics as an elective course based upon their interests. The majority of our students, however, come from the School of Business where these introductory courses in microeconomics and macroeconomics are required core courses for all business majors. Again, there is a considerable range of majors within the business program (accounting, finance, supply chain management, human resources, marketing).

Combined, we see a significant diversity of students, with broad interests and backgrounds, in these principles of economics courses and, therefore, no *a priori* reason why students with visual (V) learning preferences would necessarily represent a majority (or even a significant proportion) of students. Recent VARK studies surveying business students (Awang et al., 2017; Espinoza-Poves, Miranda-Vílchez & Chafloque Céspedes, 2019) also found visual learners (V) representing the lowest percentage of participants. We could conceivably see an increase in ratio of visual learners in *upper-year* economics courses where, based on their experience, successful visual learners in the principles of economics courses choose to enroll in additional economics courses or even switch their major to economics. There is an opportunity for further research into VARK learning preferences along the lines of degree major (e.g., business vs. economics) and current stage of university undergraduate career (e.g., first year vs. fourth year). Given the importance of

visual learning in economics, however, consideration needs to be given to the identification and development of these skills at the introductory level.

Empirical models and findings

From our descriptive statistics analysis, we observe that over 50% of the student participants had some form of preferred learning style: unimodal, bimodal, or trimodal. Similarly, the majority of the instructors teaching these students also had preferred learning styles. In this section, we use ordinary least squares (OLS) regression to quantify the relationship between students' and instructors' preferred VARK learning styles and students' performance in introductory economics courses.

Determinants of student performance

Student performance, the dependent variable, is defined as the student's final mark in the course (Grade) and is measured in percentage terms. In addition to VARK learning styles, determinants of student performance include a variety of abilities and attributes. Ideally, an "education production function" includes student-specific attributes, relevant discipline-specific characteristics, and innate attributes such as motivation or expectations.

In our survey, we selected the student's age as a variable to capture motivation. Relative to younger high school graduates just entering university, our assumption is that older, mature students have a better understanding of what they want to accomplish and how to attain these goals at post-secondary institutions. On average, we anticipate that older students have higher grades.

Student gender is selected as a sociological/cultural variable that can potentially identify discipline-specific gender gaps. The traditional gender gap in economics favours men (i.e., on average males have higher final grades than females). There is a growing body of literature, however, suggesting that once innate attributes including personality traits and/or learning styles are included, this traditional gender gap favouring males is no longer statistically significant and may even be reversed (Borg & Stranahan, 2002; Ballard & Johnson, 2005; Opstad & Fallan, 2010; Leung et al., 2014; Sabiston, Leung & Terrazzano, 2017). Consequently, the sign associated with gender may be positive or negative.

High school grades in mathematics (Math 30) and language/arts (LA 30) account for separate discipline-specific abilities which are important in understanding fundamental economic principles. These two courses are minimum requirements for acceptance into business and economic programs and all students registering in principles of economics courses would have completed these courses successfully, or their equivalent for out-of-province and international students. Ideally, high school grades in economics would be preferable since it would enable us to consider the role of VARK across different educational settings. Unfortunately, not all high schools offer a course in economics, nor is it a pre-requisite for the introductory courses in post-secondary institutions. Previous academic success at the high school level also addresses endogeneity problems and we

expect that higher grades at this level are positively related to performance in university economics courses (Ballard & Johnson, 2004; Cyrenne & Chan, 2012; Allgood, Walstad & Siegfried, 2015; Allensworth & Clark, 2020).

Finally, we include the students' number of hours of paid work per week. The amount of time available to attend lectures, complete assignments, study for quizzes/exams, and engage in other course-related activities is an important factor. Anecdotal evidence suggests there is a growing trend amongst students towards working more part time (and full time) hours during the academic year; our survey indicates that, on average, our students work over 11 hours per week. Since more working hours reduces the available hours available for academic work, we anticipate a negative sign associated with the number of hours of paid work per week.

Models and results

Given our explanatory variables, we initially estimated a benchmark education production function of the form:

$$\text{Grade} = f(\text{Age, Gender, Math 30, LA 30, Hours worked, V, A, R, K}) \quad (1)$$

where the raw scores for the V, A, R, and K modalities are recoded in a binary form; a value of 1 indicates a strong preference for a specific learning style, otherwise the value is 0. This regression provides a general idea of how individual student's attributes and abilities determine their performance in the principles of economics courses without examining the role of the instructor's learning preference or gender.

The results of this regression are presented in Table 3 under the *Model 1* column. We see that the coefficients for two attributes, age and gender are both positive and statistically significant at the 10% and 5% level respectively. For the age variable, this suggests that each additional year tends, on average, to increase the final grade by half a percentage point. In the case of gender, females average 4% higher final grades than their male colleagues, indicating a reversal of the traditional gender gap. We also observe that past academic performance in high school is a good indicator of performance in principles courses in university as the coefficients for both mathematics (Math 30) and language/arts (LA 30) are positive and statistically significant at the 1% level. While the hours worked per week has the anticipated negative sign on performance, the value is relatively small (i.e., 10 hours per week would only lower the final grade by 1%) and not statistically different from the value of zero.

With the use of tables and graphs, the presentation of economic principles relies heavily on a visual approach. It is not surprising, therefore, when we examine the role of students' learning styles, we see that students with a preference towards visual learning (V) have an increase, on average, of over 6% in final grades compared to non-visual learners. Moreover, this coefficient is statistically significant at the 1% level. The coefficients for the other three learning styles (aural = 2.08, read/write = -1.2, and kinesthetic = 1.83), however, are not statistically significant.

Table 3: OLS regression results

Independent variable	*Model 1* Student VARK		*Model 2* Student and instr. VARK		*Model 3* Student and common VARK	
	Coefficient (std err.)	t statistic	Coefficient (std err.)	t statistic	Coefficient (std err.)	t statistic
Age	0.48 (0.27)	1.79*	0.51 (0.28)	1.82*	0.54 (0.28)	1.91*
Gender	3.95 (1.99)	1.98**	3.09 (2.07)	1.49	3.41 (1.99)	1.71*
Math 30	0.31 (0.10)	3.13***	0.30 (0.10)	2.98***	0.29 (0.10)	3.01***
LA 30	0.40 (0.15)	2.64***	0.41 (0.14)	2.86***	0.42 (0.14)	2.99***
Hours worked/week	-0.12 (0.08)	-1.48	-0.13 (0.08)	-1.64	-0.12 (0.08)	-1.53
Visual (V)	6.76 (2.34)	2.88***	6.00 (2.23)	2.68***	7.29 (2.61)	2.79***
Aural (A)	2.08 (2.23)	0.93	1.43 (2.29)	0.63	1.78 (2.19)	0.81
Read/write (R)	-1.20 (2.37)	-0.51	-0.80 (2.30)	-0.45	1.10 (2.43)	0.45
Kinesthetic (K)	1.83 (2.17)	0.84	1.30 (2.18)	0.60	-3.40 (3.46)	-0.98
Instr. gender (IGender)			8.26 (3.85)	2.14**	5.67 (2.08)	2.72***
Instr. Visual (IV)			-2.32 (3.02)	-0.77		
Instr. aural (IA)			-4.19 (2.93)	-1.43		
Instr. read/write (IR)			-0.17 (3.73)	-0.05		
Instr.kinesthetic (IK)			5.35 (3.26)	1.64		
Both V					-3.02 (3.53)	-0.86
Both R					-5.25 (4.95)	-1.06
Both K					8.41 (4.07)	2.07**
Constant	5.07 (12.30)	0.41	-0.05 (12.49)	0.00	0.93 (12.13)	0.08
Adjusted R^2	0.1926		0.2496		0.2558	
Significance level: *p < .10; **p < .05; ***p < .01 Gender/Instructor Gender: female = 1 Number of observations = 159						

To capture the role of the instructors in determining students' performances we supplement *Model 1* by including the instructors' gender (IGender) and their VARK learning styles (IV, IA, IR, IK) and estimate the following function:

Grade = f (Age, Gender, Math 30, LA 30, Hours worked, V, A, R, K, IGender, IV, IA, IR, IK) (2)

The results of this regression are presented in Table 3 under the *Model 2* column. With the exception of the students' gender, all the statistically significant variables in *Model 1* remain significant at the same level of significance (Age, Math 30, LA 30, and V). While student's gender is no longer statistically significant at the 10% level, its t-value of 1.49 (p = 0.138) suggests that it still adds value to the regression.

Looking at the role of the instructor, we see that the instructor's gender is significant at the 5% level. The coefficient implies that, on average, any student whose instructor is female has an 8% increase in their final grade, relative to students with male instructors. From the descriptive statistics section, we observe that average final grades for female instructors are approximately 6.2% higher than their male colleagues. At this stage, it would be difficult to ascribe the difference to simply "better teaching" on behalf of the

female instructors since there are no common exams or tests, no common assignments, and no common textbook (although all instructors are limited to a choice of three texts). More importantly, we have not investigated individual teaching styles. Teaching to the assessments, scaffolding outcomes, and engaging in various forms of active learning in the classroom are all potential educational variables which could contribute to the discrepancy. We also note that the female contract instructors only taught introductory microeconomics, so content (micro vs. macro) as well as the precarious nature of contract academic staff may also explain some of this variance. These are all potential lines of inquiry for future research into the role of instructors on student performance.

In terms of the instructors' preferred learning styles, we see two interesting features. Firstly, three out of the four preference learning styles (visual, aural, and read/write) have negative coefficients but are not statistically significant. Even though the coefficients are not statistically significant, we can see why they might produce negative effects on students' performances. If instructors *teach* uniquely along these preferred learning styles, none of them adequately prepares students for the varied assessments which all require visual, mathematical, and written skills.

This leads us to the second interesting feature; namely the role of instructors with a kinesthetic learning style. This is the only preferred learning style which has a positive coefficient. While it is not statistically significant, its t-value of 1.65 ($p = 0.103$) is at the cusp of being significant at the 10% level. Of the four preferred instructors' learning styles, this one appears to have the most relevance.

The final regression analysis in Table 3 adopts the instructor-student match (congruence) line of inquiry. Rather than focusing on the individual preferred learning styles of instructors, *Model 3* examines the effect of similarities of learning styles between students and their instructors. The regression takes the form of:

$$\text{Grade} = f(\text{Age, Gender, Math 30, LA 30, Hours worked, V, A, R, K, IGender, Both V, Both R, Both K}) \quad (3)$$

where "Both *i* " are binary variables (0,1) and represent cases where student and instructor share the same learning style. For example, if a student and her instructor are both visual learners, the values for their V and IV are equal to 1 and the new variable Both V also takes on the value of 1. Since the new "BOTH *i*" variables are linearly related to the individual students' i values, there is a risk of high multicollinearity. This increases the variance of the coefficient estimates to the point where the coefficients can be sensitive to minor changes in the model. Examining correlation coefficients, we notice a high correlation between V and Both A. Given that V is highly statistically significant in the two previous regressions, whereas Both A is not statistically significant, we drop the variable Both A from the regression.

There is a pattern emerging in *Model 3* with respect to students' attributes and abilities. Once again, the statistically significant variables in *Model 1* remain significant at the same level of significance (Age, Math 30, LA 30, and V); only gender has dropped from a 5% level of significance to a 10% level. Similarly, the coefficients for the other three learning

styles (aural, read/write, and kinesthetic) are not statistically significant. The coefficient associated with the instructor's gender has fallen from 8.26 to 5.67 but the level of significance has risen from 5% to 1%.

Of our new variables identifying the importance of instructor-student learning style congruence, we see that Both V and Both R have negative coefficients but are not statistically significant. The variable, Both K, however, is statistically significant at a 5% level. We can interpret this coefficient to say that, on average, when both student and instructor have preferred kinesthetic learning styles, students' performance on principles of economics courses is 8.4% higher than those students who do not share this preferred learning style with their instructor. This is assuming that the value for K, not being statistically significant, is set equal to zero. If we include the value of K = -3.4, the net effect reduces the increase in performance to 5% rather than 8.4%.

In summary, we see that previous academic success in high school (Math 30 & LA 30), age, and to a certain extent, student's gender, all contribute to higher grades in principles of economics courses. In terms of their learning styles, those students who have a preference for visual learning (V) benefit the most at this introductory level. Instructor's gender is also important – female instructors have higher average grades in their sections relative to their male colleagues – but the source(s) of this difference requires additional research. Finally, the average grades of those students who share a similar kinesthetic learning (Both K) with their instructor are significantly higher than students who share other preferred learning styles.

Limitations

There are limitations with respect to the role of instructors, in the sense that we've restricted their influence on student performance to (i) gender, and (ii) VARK learning modalities, including their congruence with students. The limited sample size of instructors (eight) also poses constraints on a more detailed discussion of instructors' abilities since it can reveal an individual instructor's identity. Future research, with a larger sample of instructors, can expand on the instructors' role by including, for example, differences across teaching styles, content (micro vs. macro), and employment status (contract academic staff vs. tenured faculty).

Our study is also limited to quantitative analysis and numerical conclusions. Qualitative evidence through in-depth interviews with instructors, for example, can provide more detailed information on how they came about their respective VARK preferences, and how these preferential learning styles may have influenced their teaching styles. When the majority of students and instructors have one or more VARK learning preferences, students' motivation and effectiveness in learning will likely increase if instructors can practice multimodal presentation methods in their teaching to compensate for students' different cognitive learning styles (Chang 2019; Lee 2019; Sankey, Birch & Gardiner 2010). The relationship between VARK preference and student performance as a response to multimodal presentations in economics teaching is worth exploring.

Another limitation is the focus on the VARK inventory in this study. As discussed in the literature review, the choice of a proxy for learning styles (e.g., Myers-Briggs personality tests, VARK modalities, Keirsey-Bates temperaments) may affect the degree of the influence that learning styles have on student performance. The comparison of different measures and survey instruments is an important topic within the study of survey design but is beyond the scope of this article and requires further research.

Conclusion

A growing body of literature in economics education research considers the potentially important relationship between learning style preferences and student performance in principles of economics. Evidence consistently shows that students with a visual learning style preference tend to perform better in principles of economics even after controlling for students' abilities and attributes. The traditional gender gap in economics which favours men has found to be weakened or even reversed once innate attributes such as learning style preferences of students are accounted for. Matching learning style preferences between students and instructors is an interesting idea that has not yet received much attention in the economics education literature and deserves further exploration.

In this research, we used a sample of students and instructors recruited from both principles of microeconomics and principles of macroeconomics courses to explore the relationship between learning style preferences and student performance. Our descriptive statistics indicate that 55% of the students and 75% of the instructors in our sample have one or more preferred learning styles. Amongst the four learning styles of the VARK inventory, the highest number of students identify kinesthetic as a preferred learning style. Furthermore, all instructors who show multimodal preferences have kinesthetic as one of their preferred learning styles. It would be interesting to know at what stage these instructors developed the preference for the kinesthetic learning style. For instance, did they come into the discipline with such a preference or did they have other learning styles but recognised, as teachers, that they needed to adopt a kinesthetic approach to teaching?

Another interesting observation from this study relates to the role of gender (student and instructor) and student performance. When learning style preferences of instructors are not accounted for, female students in our study average 4% higher final grades than their male colleagues at a 5% level of statistical significance (*Model 1*). The statistical significance of this coefficient associated with student gender, however, decreases after accounting for instructors' learning style preferences (*Model 2*) and instructor-student congruence of learning style preferences (*Model 3*). This implies that matching learning style preferences of students and instructors can possibly moderate the relationship between student gender and student performance. Results in this study also show that the final grade of students, on average, increases by more than 5% when a student's instructor is female instead of male, even after the inclusion of students' and instructors' learning style preferences in the analysis. More research is required to further understand the intricate relationship between gender, learning style preferences, and student performance.

Our regression analysis indicates that students with a preference towards visual learning have an increase, on average, of over 6% in final grades compared to non-visual learners, even after controlling for students' attributes and abilities. This is largely consistent with findings from previous literature, and likely a result of how principles of economics courses are traditionally taught with an emphasis on graphical analysis. On matching learning style preferences between students and instructors, students' performance in principles of economics courses increases significantly by at least 5% in comparison to their classmates when both student and instructor have preferred kinesthetic learning styles. This result lends support to the suggestion that active classroom learning strategies and experiments can help to improve learning for students with kinesthetic learning style preferences (Bhadra 2006; Durham, McKinnon & Schulman 2007; Huesca Juárez & Medina Herrera 2019). At the same time our results also serve as contrasting evidence to that of Brooks and Khandker (2013) who found no significant relationship between instructor-student learning style preferences match and student performance in principles of microeconomics.

Overall this study has identified various significant relationships between VARK learning style preferences and student performance in principles of economics. Our empirical results provide support for applying the VARK methodology in the design of teaching and learning approaches as suggested by Wright & Stokes (2015). In the meantime, given the contradictory evidence in the current economics education literature, more empirical studies – across different regional and cultural contexts – are required to further explore the importance of instructor-student learning style congruence on student performance.

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