Colorado Department of Higher Education
Division of Research, Planning and Performance

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Online versus Traditional Learning: A Comparison Study of Colorado Community College Science Classes

Introduction

Students are currently given more and more options in postsecondary education be it the traditional format in the classroom, in a virtual world online, or a hybrid of the two options. The Colorado Community College System (CCCS) offers numerous courses both in the traditional and online format. Recently in Colorado discussions regarding traditional and online courses have centered on science courses. This study conducted by the Colorado Department of Higher Education compares students enrolled at the Colorado Community College System in traditional and online science courses. The second part of the study tracks these same students into a four year institution and compares academic performance in science courses.

Methodology

This study compared the experiences of Colorado community college students in online and traditional science classes, specifically BIO 111 and BIO 112, CHE 111 and CHE 112, and PHY 111 and 112. Participants were students enrolled in the Colorado Community College System (CCCS). Two random samples were pulled from the CCCS database: a random sample of students who were enrolled in the above mentioned science classes offered in the traditional format and a second group comprised of complete set of students who were enrolled in the above mentioned science classes offered online. The random sample of students taking science courses in the traditional format was matched in size roughly to the complete set of students taking the sciences courses online. The subjects self selected into either the online or traditional course format. Data were pulled for academic years Fall 2007 to Fall 2009. The CCCS file was matched with appropriate data from the DHE Student Unit Record Data System (SURDS). This file provided information on students who took science courses in the community college system and then transferred to a four-year public institution within the state. Descriptive statistics and independent sample t-tests were employed to determine if any differences exist between the students enrolled online and in the traditional format.

Results

The sample of CCCS students totaled 4,585 and was comprised of 2,395 students taking science courses online and 2,190 students completing traditional science courses in the classroom.

	Frequency	Percent
Online	2395	52.2
Traditional	2190	47.8
Total	4585	100.0

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The disaggregation by type of science class is as follows:

	Frequency	Percent
Biology	1654	36.1
Chemistry	1855	40.5
Physics	1076	23.5
Total	4585	100.0

Descriptive statistics for cumulative GPA, cumulative credit hours, and grade in online or traditional science course are provided below by the class format. Students in the online science courses had higher average cumulative GPAs (2.95) compared to 2.89 for students enrolled in traditional science courses. Online students also had higher average cumulative credit hours (99.6) compared to 82.4 for students in the traditional classrooms. Students in the traditional classrooms had slightly higher average grades in the science courses (2.83) compared to 2.71 for students in the online science courses.

		N	Mean	Std. Deviation	Std. Error Mean
Cumulative GPA	Online	2367	2.9459	.78284	.01609
	Traditional	2176	2.8780	.81834	.01754
Cum. Credit Hours	Online	1347	99.5940	41.31214	1.12563
	Traditional	1184	82.4397	32.85498	.95483
Science Grade	Online	1682	2.7107	1.22603	.02989
	Traditional	1565	2.8331	1.02676	.02595

Independent T-tests were run on the cumulative GPA, cumulative credit hours, and science grade to determine if there were any statistical differences between the students completing the science courses online or in the physical classroom. Results show there is a statistical difference between all three variables (cumulative GPA, cumulative credit hours, and science grades) and students completing the courses either online or in traditional format, p=.05.

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		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Cumulative GPA	Equal variances assumed	2.857	4541	*.004	.06788	.02376
	Equal variances not assumed	2.852	4467.376	.004	.06788	.02380
Cum Credit Hrs.	Equal variances assumed	11.454	2529	*.000	17.15429	1.49762
	Equal variances not assumed	11.622	2504.529	.000	17.15429	1.47605
Science Grade	Equal variances assumed	-3.072	3245	*.002	-.12240	.03984
	Equal variances not assumed	-3.092	3210.012	.002	-.12240	.03959

*Statistically significant, p=.05

Next, average means for cumulative GPA, cumulative credit hours, and science grades were run by type of science class: Biology, Chemistry, or Physics and not by teaching format. Results show that students enrolled in Physics classes have on average a higher cumulative GPA (2.97), higher cumulative credit hours (101.1) and higher on average science grades (3.01) compared to students enrolled in the Biology or Chemistry classes. Additionally, students enrolled in Chemistry classes tend to perform on average slightly higher than students enrolled in Biology classes. An ANOVA was run to determine if these differences were statistically significant and results show these differences are statistically significant at the p=.05 level. Results are shown in the tables below.

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		N	Mean	Std. Deviation	Std. Error
Cum GPA	Biology	1639	2.8700	.85053	.02101
	Chemistry	1839	2.9205	.80630	.01880
	Physics	1065	2.9677	.70281	.02154
	Total	4543	2.9134	.80067	.01188
Cum Credit hours	Biology	744	80.3665	31.83951	1.16729
	Chemistry	1059	92.8582	38.86564	1.19431
	Physics	728	101.1431	41.40576	1.53460
	Total	2531	91.5692	38.54890	.76624
Science Grades	Biology	1093	2.6710	1.16274	.03517
	Chemistry	1337	2.7010	1.09556	.02996
	Physics	817	3.0142	1.13007	.03954
	Total	3247	2.7697	1.13584	.01993

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Cumulative GPA	Between Groups	6.319	2	3.159	4.937	*.007
	Within Groups	2905.422	4540	.640		
	Total	2911.741	4542			
Cum Credit Hrs.	Between Groups	161859.893	2	80929.947	56.866	*.000
	Within Groups	3597764.059	2528	1423.166		
	Total	3759623.952	2530			
Science Grades	Between Groups	65.803	2	32.902	25.894	*.000
	Within Groups	4121.955	3244	1.271		
	Total	4187.758	3246			

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To parcel out these differences between the categories of science courses and the classroom format additional descriptive statistics and t-tests were conducted.

Biology Science Courses

		N	Mean	Std. Deviation	Std. Error Mean
Cum GPA	Online	674	2.8545	.84800	.03266
	Traditional	965	2.8809	.85257	.02745
Cum Credit Hrs.	Online	284	83.0134	33.28996	1.97540
	Traditional	460	78.7324	30.83354	1.43762
Grades	Online	412	2.4777	1.31537	.06480
	Traditional	681	2.7880	1.04355	.03999

		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Cum GPA	Equal variances assumed	-.618	1637	.536	-.02641	.04270
	Equal variances not assumed	-.619	1453.087	.536	-.02641	.04266
Cum Credit Hrs.	Equal variances assumed	1.784	742	.075	4.28099	2.39926
	Equal variances not assumed	1.752	564.525	.080	4.28099	2.44314
Grade	Equal variances assumed	-4.310	1091	.*000	-.31029	.07200
	Equal variances not assumed	-4.075	720.460	.000	-.31029	.07615

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Results show that cumulative GPAs and cumulative credit hours completed are similar for students in either online or traditional Biology classes. Students completing Biology classes in the traditional format have statistically significant higher grades in these classes compared to students in online classes.

Chemistry Science Courses

		N	Mean	Std. Deviation	Std. Error Mean
Cum GPA	Online	964	2.9717	.79312	.02554
	Traditional	875	2.8641	.81732	.02763
Cum Credit Hrs.	Online	550	102.4296	42.12319	1.79614
	Traditional	509	82.5157	31.96918	1.41701
Grades	Online	692	2.6153	1.16480	.04428
	Traditional	645	2.7929	1.00888	.03972

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		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Cum GPA	Equal variances assumed	2.865	1837	*.004	.10764	.03757
	Equal variances not assumed	2.861	1807.873	.004	.10764	.03763
Cum Credit Hrs.	Equal variances assumed	8.614	1057	*.000	19.91392	2.31178
	Equal variances not assumed	8.704	1018.622	.000	19.91392	2.28780
Grade	Equal variances assumed	-2.970	1335	*.003	-.17755	.05979
	Equal variances not assumed	-2.985	1327.932	.003	-.17755	.05949

*Statistically significant, p=.05

Results show that cumulative GPAs, cumulative credit hours completed, and Chemistry grade are statistically significantly different for students in either online or traditional Chemistry classes. Online Chemistry students have on average higher cumulative credit hours completed and GPAs compared to Chemistry students in the physical classroom. Students completing Chemistry classes in the traditional format have statistically significant higher grades in these classes compared to students in online classes.

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Physics Science Courses

		N	Mean	Std. Deviation	Std. Error Mean
Cum GPA	Online	729	2.9962	.69549	.02576
	Traditional	336	2.9059	.71561	.03904
Cum Credit Hrs.	Online	513	105.7329	42.10348	1.85891
	Traditional	215	90.1916	37.57724	2.56275
Grade	Online	578	2.9910	1.18048	.04910
	Traditional	239	3.0703	.99777	.06454

		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Cum GPA	Equal variances assumed	1.951	1063	.051	.09027	.04628
	Equal variances not assumed	1.930	634.814	.054	.09027	.04677
Cum Credit Hrs.	Equal variances assumed	4.686	726	*.000	15.54132	3.31647
	Equal variances not assumed	4.909	446.742	.000	15.54132	3.16595
Grade	Equal variances assumed	-.912	815	.362	-.07929	.08692
	Equal variances not assumed	-.978	521.218	.329	-.07929	.08110

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Results show that cumulative credit hours completed are statistically significantly different for students in either online or traditional Physics classes. Online Physics students have on average higher cumulative credit hours completed than Physics students in the physical classroom. Cumulative GPAs and Physics grades were similar for students in either format of class.

Discussion

The results suggest that there are some differences between students enrolled in science classes in either the online or traditional format. However, these differences appear to vary by the type of science courses: Biology, Chemistry, or Physics. The greatest difference in general between the students in the two forms of classroom delivery appears to be with grades earned in these science classes. Students in traditional classrooms tend to receive, on average, higher grades that students in online classes. However, this only applies to students completing Biology and Chemistry classes. Grades earned in Physics appear to be the similar for both online and traditional students. Despite online students receiving lower marks in Biology and Chemistry classes these students have either very similar or even slightly higher GPAs than students completing these courses in the traditional format. Additionally, the online students in all three science disciplines have either similar or higher cumulative credit hours earned. The interpretations of these results are subjective and wide. Higher grades could be a combination of numerous factors such as more stringent grading of online courses to counter an unfounded perception of online courses or that students perform slightly better in the physical classroom. The differences between the science programs could be a difference in the types of students that select each discipline. Higher GPAs and higher on average cumulative hours completed by online students could suggest more experienced and academically prepared students self select online courses. To truly determine the interpretations of these results more research needs to be conducted. Future research could consist of evaluating CCCS students performance in four year institutions by major to evaluate how students perform in various science related majors or completion of programs for these students could be evaluated. Overall, the students enrolled in either online or traditional science classes tend to be performing fairly well academically and earning a healthy amount of credits towards a degree.

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Online/Traditional Part 2

Of the 4,585 students sampled in the initial CCCS study, 936 were found at one of 4 four-year institutions (i.e. CU-Boulder, CU-Denver, CU-Colorado Springs, and CSU). Six hundred and thirty (630) of these students had completed at least one Biology, Chemistry or Physics course and some students enrolled in multiple courses across subject. The sample was further limited to students who had either taken an online course or a traditional course at a CCCS institution (students who had taken both were excluded from the sample). This reduced the sample to 444 students. An average Science grade point average (GPA) at the four-year institution was calculated for each student along with Biology, Chemistry and Physics GPAs. Using independent sample t-tests, average GPAs were compared. There were no statistically significant differences in students' Science GPAs across instructional method (online vs. traditional). This suggests that online CCCS students perform just as well in Science classes at four-year institutions as their on-campus counterparts. Further, there were no significant differences in Biology, Chemistry and Physics GPAs between online and traditional students.

Table 1: Mean GPA by Subject and Instruction Method

		Count	Mean GPA
Science GPA	Online	107	2.56
	Traditional	337	2.58
Biology GPA	Online	33	2.60
	Traditional	128	2.72
Chemistry GPA	Online	65	2.36
	Traditional	251	2.53
Physics GPA	Online	63	2.70
	Traditional	234	2.90

*No statistically significant differences