segmentation-clustering-analytics

```
student_performance <- read.csv("TUMO Yerevan_Students Performance_Table - Sheet1.csv")
```

```
str(student_performance)
```

```
## 'data.frame':    10139 obs. of  14 variables:
##  $ TumoID                : num  2.41e+11 2.41e+11 2.31e+11 2.30e+11 2.50e+11 ...
##  $ Age                   : int  14 13 14 14 13 13 13 15 20 14 ...
##  $ Classification        : chr  "T" "T" "M" "M" ...
##  $ Schedule              : chr  "Sunday 13:30" "Monday 17:30" "Sunday 13:30" "Tuesday 19:30" ...
##  $ Status                : chr  "Active" "Preclosed" "Active" "Active" ...
##  $ RetentionGrouped      : chr  "0.5 - 1 Year" "0.1 - 0.5 Year" "1.5 - 2 Year" "2 - 2.5 Year" ...
##  $ Awarded               : int  38 8 36 35 12 13 19 20 22 52 ...
##  $ Rejected              : int  6 0 4 2 4 2 1 3 0 1 ...
##  $ Completed             : int  1 0 5 4 0 0 1 2 0 6 ...
##  $ Incomplete            : int  0 0 0 2 0 0 0 0 0 1 ...
##  $ Participated          : int  0 0 0 0 0 1 2 0 0 0 ...
##  $ Withdrawn             : int  0 0 0 2 0 0 0 0 1 1 ...
##  $ LearningLabs.Completed: int  0 0 1 2 0 0 0 0 0 0 ...
##  $ AttendingSince        : chr  "10/10/2024" "2/10/2025" "12/7/2023" "6/6/2023" ...
```

```
student_info <- read.csv("TUMO Yerevan Center Report_Students List_Table - Sheet1.csv", colClasses = c(
str(student_info) #
```

```
## 'data.frame':    10428 obs. of  11 variables:
##  $ TumoID           : chr  "2.30326E+11" "2.30113E+11" "2.40401E+11" "2.50414E+11" ...
##  $ BirthDate        : chr  "11-Jul-10" "9-Nov-10" "20-Mar-12" "29-Jan-13" ...
##  $ Classification   : chr  "M" "U" "T" "T" ...
##  $ Status           : chr  "Active" "Active" "Active" "Active" ...
##  $ StudentSchedule  : chr  "Sunday 13:30" "Friday 17:30" "Wednesday 15:30" "Wednesday 19:30" ...
##  $ AttendingSince   : chr  "14-Sep-23" "12-Apr-23" "5-Jun-24" "7-May-25" ...
##  $ RetentionByMonths: int  22 27 13 2 27 21 18 6 6 8 ...
##  $ RetentionGrouped : chr  "1.5 - 2 Year" "2 - 2.5 Year" "1 - 1.5 Year" "0.1 - 0.5 Year" ...
##  $ Age              : int  15 14 13 12 14 15 14 14 12 12 ...
##  $ Present          : chr  "109" "120" "64" "13" ...
##  $ PresenceRatio    : chr  "85" "90" "86" "81" ...
```

```
student_info$TumoID <- as.numeric(student_info$TumoID)
options(scipen = 999)
```

```
table(student_info$TumoID)
```

```
##
##   1108300232   1406170020   1410290040   1411080044   1509260009   1510280006
```

```
##           1           1           1           1           1           1
##  1604070003  1607270031  1607280011  1609060032  1610170018  1702169962
##           1           1           1           1           1           1
##  1703130023  1703130038  1703230035  1703230037  1707040026  1708240029
##           1           1           1           1           1           1
##  1709110008  1709280010  1710090006  1710130007  1711230003  1712060014
##           1           1           1           1           1           1
##  1801180031  1801220012  1801300019  1802070021  1802120000  1802270037
##           1           1           1           1           1           1
##  1802280007  1803020000  1803160012  1804100009  1805040010  1806120027
##           1           1           1           1           1           1
##  1806180021  1806190030  1806260014  1807100044  1807110026  1807170039
##           1           1           1           1           1           1
##  1807180044  1808230016  1809050025  1809120022  1809130022  1809270003
##           1           1           1           1           1           1
##  1809290002  1810050010  1810170015  1810170017  1810190043  1810240025
##           1           1           1           1           1           1
##  1810290011  1810300044  1811190022  1811290033  1812030001  1812110032
##           1           1           1           1           1           1
##  1812210015  1901240011  1901300009  1902110003  1902130000  1902180008
##           1           1           1           1           1           1
##  1902200006  1903190001  1903190003  1903220022  1903220035  1903260005
##           1           1           1           1           1           1
##  1903260009  1903260019  1903270014  1903280003  1904020010  1904020030
##           1           1           1           1           1           1
##  1904030001  1904040004  1904040014  1904040033  1904220039  1904230048
##           1           1           1           1           1           1
##  1904250003  1904250136  1904250145  1904260040  1904270053  1905170006
##           1           1           1           1           1           1
##  1905200005  1905220020  1905270011  1905310020  1906030014  1906030033
##           1           1           1           1           1           1
##  1906050001  1906170004  1906260005  1906270022  1907030011  1907080019
##           1           1           1           1           1           1
##  1907090012  1907110018  1907170006  1909060020  1909060021  1909070011
##           1           1           1           1           1           1
##  1909190014  1909240022  1909250017  1909260028  1910030013  1910040032
##           1           1           1           1           1           1
##  1910070034  1910080030  1910110031  1910140005  1910140020  1910140022
##           1           1           1           1           1           1
##  1910150019  1910170004  1910170006  1910170019  1910210024  1910230018
##           1           1           1           1           1           1
##  1910250004  1910250019  1910290052  1911010037  1911040027  1911040049
##           1           1           1           1           1           1
##  1911050026  1911050033  1911060003  1911070007  1911070040  1911070041
##           1           1           1           1           1           1
##  1911080034  1911120007  1911120022  1911140010  1911200008  1911210021
##           1           1           1           1           1           1
##  1911220031  1911270002  1911270015  1911290019  1912030010  1912050020
##           1           1           1           1           1           1
##  1912090004  1912090014  1912090017  1912130021  1912270004  1912270005
##           1           1           1           1           1           1
##  1912270019  2001130030  2001140018  2001140047  2001160035  2001170030
##           1           1           1           1           1           1
##  2001170047  2001200045  2001200053  2001230056  2001290042  2001290045
```

```
##           1           1           1           1           1           1
##  2001310072  2001310080  2002030020  2002040027  2002070016  2002070026
##           1           1           1           1           1           1
##  2002100028  2002110050  2002130013  2002130028  2002170002  2002190006
##           1           1           1           1           1           1
##  2002200015  2002210019  2003030005  2003040022  2003050013  2003050016
##           1           1           1           1           1           1
##  2003090000  2003100035  2003110019  2003110043 150603000000 161107000000
##           1           1           1           1           1           1
## 171116000000 180916000000 190317000000 190328000000 190910000000 191016000000
##           1           1           1           1           1           1
## 200123000000 200514000000 200714000000 200715000000 200716000000 200720000000
##           1           1           1           3           1           3
## 200721000000 200726000000 200727000000 200728000000 200729000000 200730000000
##           1           1           1           1           2           1
## 200731000000 200802000000 200829000000 200831000000 200901000000 200903000000
##           3           1           1           1           2           3
## 200904000000 200905000000 200906000000 200908000000 200909000000 200910000000
##           4           4           1           2           2           1
## 200911000000 200912000000 200922000000 201103000000 201104000000 201105000000
##           1           2           1           1           1           6
## 201107000000 201108000000 201109000000 201112000000 201113000000 201114000000
##           1           1           5           2           2           1
## 201115000000 201117000000 201119000000 201216000000 201217000000 201218000000
##           5           1           1           1           5           1
## 201219000000 201220000000 201222000000 201223000000 210206000000 210211000000
##           3           3           1           1           1           3
## 210212000000 210213000000 210215000000 210217000000 210218000000 210219000000
##           4           1           3           3           3           2
## 210220000000 210221000000 210222000000 210223000000 210224000000 210305000000
##           2           3           4           1           1           3
## 210306000000 210307000000 210309000000 210310000000 210311000000 210312000000
##           1           1           4           4           6           8
## 210313000000 210314000000 210315000000 210318000000 210323000000 210329000000
##           6           1           2           4           1           1
## 210330000000 210331000000 210401000000 210403000000 210405000000 210406000000
##           3           4           4           5           5          10
## 210407000000 210408000000 210409000000 210410000000 210411000000 210413000000
##           2           1           1           1           1           6
## 210414000000 210415000000 210416000000 210417000000 210418000000 210420000000
##           2           7           2           8           4           4
## 210422000000 210423000000 210425000000 210426000000 210428000000 210429000000
##           5           3           4           3           5           5
## 210430000000 210502000000 210503000000 210504000000 210505000000 210506000000
##           4           6           4           2           6           2
## 210507000000 210510000000 210512000000 210514000000 210515000000 210518000000
##           4           1           1           2           7           1
## 210519000000 210520000000 210524000000 210526000000 210527000000 210529000000
##           1           2           2           4           1           3
## 210530000000 210531000000 210602000000 210603000000 210604000000 210605000000
##           1           8           2           2           4           5
## 210606000000 210607000000 210608000000 210609000000 210610000000 210611000000
##           3           2           4           1           3           3
## 210613000000 210614000000 210615000000 210616000000 210617000000 210618000000
```

```
##            1            5            1            4            2            3
## 210619000000 210621000000 210622000000 210623000000 210624000000 210625000000
##            2            4            5            4            3            2
## 210626000000 210627000000 210628000000 210629000000 210630000000 210701000000
##            2            1            3            3            2            1
## 210702000000 210703000000 210704000000 210706000000 210707000000 210708000000
##            4            1            1            3            3            5
## 210709000000 210710000000 210712000000 210713000000 210714000000 210715000000
##            2            1            5            3            1            1
## 210716000000 210717000000 210718000000 210719000000 210720000000 210721000000
##            1            4            2            4            7            4
## 210722000000 210723000000 210724000000 210726000000 210727000000 210728000000
##            1            3            1            2            6            2
## 210729000000 210730000000 210731000000 210824000000 210825000000 210826000000
##            4            6            4            2            7            8
## 210827000000 210830000000 210831000000 210901000000 210902000000 210903000000
##            5            9            4            4            4            5
## 210906000000 210907000000 210908000000 210909000000 210910000000 210911000000
##            1            4            4            5            2            1
## 210912000000 210913000000 210914000000 210915000000 210916000000 210917000000
##            3            2            2            4            4            4
## 210918000000 210919000000 210920000000 210922000000 210923000000 210924000000
##            1            2            3            6            6            4
## 210925000000 210926000000 210927000000 210928000000 210929000000 210930000000
##            1            1            4            4            1            2
## 211001000000 211002000000 211004000000 211005000000 211006000000 211007000000
##            1            2            3            4            8            2
## 211008000000 211009000000 211010000000 211011000000 211012000000 211013000000
##            2            2            2            2            1            3
## 211014000000 211015000000 211016000000 211017000000 211018000000 211019000000
##            3            3            1            1            3            3
## 211020000000 211021000000 211022000000 211024000000 211025000000 211026000000
##            1            2            1            3            2            5
## 211027000000 211028000000 211030000000 211101000000 211102000000 211103000000
##            3            6            1            6            4            3
## 211104000000 211105000000 211106000000 211108000000 211109000000 211110000000
##            1            2            4            4            1            5
## 211111000000 211114000000 211115000000 211116000000 211117000000 211118000000
##            2            3            2            4            3            8
## 211119000000 211120000000 211121000000 211122000000 211123000000 211125000000
##            2            2            1            4            4            2
## 211126000000 211127000000 211128000000 211129000000 211130000000 211201000000
##            1            3            3            5            2            3
## 211202000000 211203000000 211204000000 211205000000 211206000000 211207000000
##            5            2            3            4            2            4
## 211208000000 211209000000 211210000000 211211000000 211212000000 211213000000
##            4            2            3            4            4            3
## 211214000000 211215000000 211216000000 211217000000 211218000000 211219000000
##            1            3            2            2            1            3
## 211220000000 211221000000 211222000000 211224000000 211225000000 211226000000
##            3            3            3            1            1            1
## 211229000000 220103000000 220105000000 220109000000 220110000000 220111000000
##            1            1            1            2            3            5
## 220112000000 220113000000 220114000000 220115000000 220116000000 220117000000
```

```
##            1            1            4            4            3            5
## 220118000000 220119000000 220120000000 220121000000 220122000000 220123000000
##            2            5            4            4            2            4
## 220124000000 220125000000 220126000000 220127000000 220128000000 220129000000
##            2            3            2            4            2            4
## 220131000000 220201000000 220202000000 220203000000 220204000000 220205000000
##            3            4            4            4            3            3
## 220206000000 220207000000 220208000000 220209000000 220210000000 220211000000
##            1            1            4            2            4            4
## 220212000000 220213000000 220214000000 220215000000 220216000000 220217000000
##            4            3            2            5            3            4
## 220218000000 220219000000 220220000000 220221000000 220222000000 220223000000
##            4            2            2            1            4            5
## 220224000000 220225000000 220226000000 220227000000 220228000000 220301000000
##            5            7            3            5            1            3
## 220302000000 220303000000 220304000000 220305000000 220306000000 220307000000
##            4            4            3            1            7            1
## 220309000000 220310000000 220311000000 220312000000 220313000000 220314000000
##            3            1            2            5            1            4
## 220315000000 220316000000 220317000000 220318000000 220319000000 220320000000
##            1            2            3            2            5            3
## 220321000000 220322000000 220323000000 220324000000 220325000000 220326000000
##            1            4            2            4            4            8
## 220327000000 220328000000 220329000000 220330000000 220331000000 220401000000
##            3            4            1            3            1            1
## 220402000000 220403000000 220404000000 220405000000 220406000000 220407000000
##            2            3            2            3            4            2
## 220408000000 220409000000 220411000000 220412000000 220413000000 220414000000
##            3            3            6            2            1            1
## 220415000000 220416000000 220417000000 220418000000 220419000000 220420000000
##            3            2            3            3            1            4
## 220421000000 220422000000 220423000000 220424000000 220425000000 220427000000
##            4            1            3            2            6            2
## 220428000000 220429000000 220430000000 220501000000 220502000000 220503000000
##            2            2            5            5            4            4
## 220504000000 220505000000 220506000000 220507000000 220508000000 220509000000
##            5            4            4            4            2            3
## 220510000000 220511000000 220512000000 220514000000 220515000000 220516000000
##            3            6            4            4            2            1
## 220517000000 220518000000 220519000000 220521000000 220522000000 220523000000
##            2            1            5            8            4            2
## 220524000000 220525000000 220526000000 220527000000 220528000000 220529000000
##            4            3            5            3            3            5
## 220530000000 220531000000 220602000000 220603000000 220604000000 220605000000
##            3            3            4            5            2            5
## 220606000000 220607000000 220608000000 220609000000 220610000000 220611000000
##            5            3            7            3            3            3
## 220612000000 220613000000 220614000000 220615000000 220616000000 220617000000
##            5            5            5            6            4            5
## 220618000000 220619000000 220620000000 220621000000 220622000000 220623000000
##            5            5            3            5            6            4
## 220624000000 220625000000 220626000000 220627000000 220628000000 220629000000
##            3            5            4            4            4            4
## 220630000000 220701000000 220702000000 220703000000 220704000000 220705000000
```

```
##            6            3            2            1            5            3
## 220706000000 220707000000 220708000000 220709000000 220710000000 220711000000
##            3            4            6            1            3            3
## 220712000000 220714000000 220715000000 220716000000 220717000000 220718000000
##            4            3            2            3            3            5
## 220719000000 220720000000 220721000000 220722000000 220723000000 220724000000
##            3            4            4            3            2            4
## 220725000000 220726000000 220727000000 220728000000 220729000000 220731000000
##            3            3            4            4           11            1
## 220801000000 220803000000 220804000000 220805000000 220806000000 220807000000
##            2            4            3            1            1            3
## 220808000000 220809000000 220810000000 220811000000 220812000000 220813000000
##            5            1            4            2            3            1
## 220814000000 220816000000 220817000000 220818000000 220819000000 220820000000
##            3            5            2            3            3            2
## 220821000000 220822000000 220823000000 220824000000 220825000000 220826000000
##            1            5            8           10            6            1
## 220827000000 220828000000 220829000000 220830000000 220831000000 220901000000
##            5            3            5            7            5            8
## 220902000000 220903000000 220904000000 220905000000 220906000000 220907000000
##            5            6            7            8            7           10
## 220908000000 220909000000 220910000000 220911000000 220912000000 220913000000
##            8            5            6            5            5            3
## 220914000000 220915000000 220916000000 220917000000 220918000000 220919000000
##            4            5            4            4            4            4
## 220920000000 220921000000 220922000000 220923000000 220924000000 220925000000
##            5            3            2            3            4            4
## 220926000000 220927000000 220928000000 220929000000 220930000000 221001000000
##            2            1            2            6            6            3
## 221002000000 221003000000 221004000000 221005000000 221006000000 221007000000
##            6            3            5            8            9            4
## 221008000000 221009000000 221010000000 221012000000 221013000000 221014000000
##            8            9            2            4            6            2
## 221015000000 221016000000 221017000000 221018000000 221019000000 221020000000
##            1            5            3            6            6            7
## 221021000000 221022000000 221023000000 221024000000 221025000000 221026000000
##            7            5            2            8            1            3
## 221027000000 221028000000 221030000000 221031000000 221101000000 221102000000
##            7           11            1            5            5            8
## 221103000000 221104000000 221105000000 221106000000 221107000000 221108000000
##            3            4            4            4            4            9
## 221109000000 221110000000 221111000000 221112000000 221113000000 221114000000
##            6            4            3            5            7            2
## 221115000000 221116000000 221117000000 221118000000 221119000000 221120000000
##            3            2            5            1            8            2
## 221121000000 221122000000 221123000000 221124000000 221125000000 221126000000
##            5            8            3            7            1            5
## 221127000000 221128000000 221129000000 221130000000 221201000000 221202000000
##            4            3            7            5            2            2
## 221203000000 221204000000 221205000000 221206000000 221207000000 221208000000
##            5            4            5            3            4            4
## 221209000000 221210000000 221211000000 221212000000 221213000000 221214000000
##            3            4            3            1            5            3
## 221215000000 221216000000 221217000000 221218000000 221219000000 221220000000
```

```
##            1            5            5            2            1            3
## 221221000000 221222000000 221223000000 221224000000 221225000000 221226000000
##            4            1            1            4            1            2
## 221227000000 221228000000 221229000000 221230000000 230101000000 230102000000
##            1            2            1            1            1            2
## 230103000000 230104000000 230105000000 230106000000 230107000000 230108000000
##            1            3            3            3            2            7
## 230109000000 230110000000 230111000000 230112000000 230113000000 230114000000
##            5           15            2            2            5            7
## 230115000000 230116000000 230117000000 230118000000 230119000000 230120000000
##            7            6           15            5            7            6
## 230121000000 230122000000 230123000000 230124000000 230125000000 230126000000
##           11            6            7            6            5            7
## 230127000000 230128000000 230129000000 230130000000 230131000000 230201000000
##            3            6            6            5            6            5
## 230202000000 230203000000 230204000000 230205000000 230206000000 230207000000
##            3            8            5            4            6            6
## 230208000000 230209000000 230210000000 230211000000 230212000000 230213000000
##            6            5            5            5            7            3
## 230214000000 230215000000 230216000000 230217000000 230218000000 230219000000
##            9            5            3            6            8            9
## 230220000000 230221000000 230222000000 230223000000 230224000000 230225000000
##            9            6            6            7            7            5
## 230226000000 230227000000 230228000000 230301000000 230302000000 230303000000
##            8            9            7            3           13            4
## 230304000000 230305000000 230306000000 230307000000 230308000000 230309000000
##            6            6            8            4            3            3
## 230310000000 230311000000 230312000000 230313000000 230314000000 230315000000
##            3            3            6            3            9            5
## 230316000000 230317000000 230318000000 230319000000 230320000000 230321000000
##            5            5            8            8           12            4
## 230322000000 230323000000 230324000000 230325000000 230326000000 230327000000
##            3            5            5            6            3            5
## 230328000000 230329000000 230330000000 230331000000 230401000000 230402000000
##            5            8            4            3            6            3
## 230403000000 230404000000 230405000000 230406000000 230407000000 230408000000
##            4           10            6            4            5            2
## 230409000000 230410000000 230411000000 230412000000 230413000000 230414000000
##            3            2            2            5           12           10
## 230415000000 230416000000 230417000000 230418000000 230419000000 230420000000
##            5            7            5            9            8            6
## 230421000000 230422000000 230423000000 230424000000 230425000000 230426000000
##            3            8            7            7            2            7
## 230427000000 230428000000 230429000000 230430000000 230501000000 230502000000
##            5            3            5            3            2            3
## 230503000000 230504000000 230505000000 230506000000 230507000000 230508000000
##            4            6            5            7            4           10
## 230509000000 230510000000 230511000000 230512000000 230513000000 230514000000
##            7            5            8           11            4            5
## 230515000000 230516000000 230517000000 230518000000 230519000000 230520000000
##           10           10            7            5            5            9
## 230521000000 230522000000 230523000000 230524000000 230525000000 230526000000
##            9           15            6            7           10            9
## 230527000000 230528000000 230529000000 230530000000 230531000000 230601000000
```

```
##            7           11            7            7            9            5
## 230602000000 230603000000 230604000000 230605000000 230606000000 230607000000
##            5            4            6            4            8           10
## 230608000000 230609000000 230610000000 230611000000 230612000000 230613000000
##            7            8            8            4            8            8
## 230614000000 230615000000 230616000000 230617000000 230618000000 230619000000
##           14           10            6            6            5           10
## 230620000000 230621000000 230622000000 230623000000 230624000000 230625000000
##            8            7           13            9            8            6
## 230626000000 230627000000 230628000000 230629000000 230630000000 230701000000
##            8            7           13            6            4           10
## 230702000000 230703000000 230704000000 230705000000 230706000000 230707000000
##            3            8            7           10           10            5
## 230708000000 230709000000 230710000000 230711000000 230712000000 230713000000
##            2            6            6            9           10            9
## 230714000000 230715000000 230716000000 230717000000 230718000000 230719000000
##            9            6            1           12            8           13
## 230720000000 230721000000 230722000000 230723000000 230724000000 230725000000
##            6            6            5            2           10            4
## 230726000000 230727000000 230728000000 230729000000 230730000000 230731000000
##           10            8           11            4            7            5
## 230801000000 230802000000 230803000000 230804000000 230805000000 230806000000
##            7            6            3            9            5            4
## 230807000000 230808000000 230809000000 230810000000 230811000000 230812000000
##            5           10            8           13            2            6
## 230813000000 230814000000 230815000000 230816000000 230817000000 230818000000
##            4           15            5           11            5            7
## 230819000000 230820000000 230821000000 230822000000 230823000000 230824000000
##            5            6           13            9           10            8
## 230825000000 230826000000 230827000000 230828000000 230829000000 230830000000
##           12           11            9           16           13           12
## 230831000000 230901000000 230902000000 230903000000 230904000000 230905000000
##            9           14            1           11           13           11
## 230906000000 230907000000 230908000000 230909000000 230910000000 230911000000
##           20            6           11            8           11           12
## 230912000000 230913000000 230914000000 230915000000 230916000000 230917000000
##           13            7           15            5            7           11
## 230918000000 230919000000 230920000000 230921000000 230922000000 230923000000
##           11            4            5            7            6            8
## 230924000000 230925000000 230926000000 230927000000 230928000000 230929000000
##            6           10            7           11            7            4
## 230930000000 231001000000 231002000000 231003000000 231004000000 231005000000
##           11           14            9            5            5            5
## 231006000000 231007000000 231008000000 231009000000 231010000000 231011000000
##            6            4            6            8            9           11
## 231012000000 231013000000 231014000000 231015000000 231016000000 231017000000
##           10           10            4           11            9            7
## 231018000000 231019000000 231020000000 231021000000 231022000000 231023000000
##            9            6            8            7            8            8
## 231024000000 231025000000 231026000000 231027000000 231028000000 231029000000
##            8           10            7           14           20           11
## 231030000000 231031000000 231101000000 231102000000 231103000000 231104000000
##            6            2            5            5            6            4
## 231105000000 231106000000 231107000000 231108000000 231109000000 231110000000
```

```
##           2           5          10           9           5          11
## 231111000000 231112000000 231113000000 231114000000 231115000000 231116000000
##           4           6           5           9           9          10
## 231117000000 231118000000 231119000000 231120000000 231121000000 231122000000
##           7          15          10           6           8           5
## 231123000000 231124000000 231125000000 231126000000 231127000000 231128000000
##           8           6           9           6           4           9
## 231129000000 231130000000 231201000000 231202000000 231203000000 231204000000
##           8           7          10           5           4           6
## 231205000000 231206000000 231207000000 231208000000 231209000000 231210000000
##           4          11           8           3           5           9
## 231211000000 231212000000 231213000000 231214000000 231215000000 231216000000
##           1           4          13           9           9           8
## 231217000000 231218000000 231219000000 231220000000 231221000000 231222000000
##           6           5           6           2           5           7
## 231223000000 231224000000 231225000000 231226000000 231227000000 231228000000
##           4           6           8           4           7           3
## 231229000000 231230000000 240101000000 240102000000 240103000000 240104000000
##           5           1           3           3           6           1
## 240105000000 240106000000 240107000000 240108000000 240109000000 240110000000
##           4           5           6          15          13          11
## 240111000000 240112000000 240113000000 240114000000 240115000000 240116000000
##          16          12          12          16          13           7
## 240117000000 240118000000 240119000000 240120000000 240121000000 240122000000
##           9           8           8          13          12          14
## 240123000000 240124000000 240125000000 240126000000 240127000000 240128000000
##          10          15          10          12           6          14
## 240129000000 240130000000 240131000000 240201000000 240202000000 240203000000
##           9           9          10           9           6          12
## 240204000000 240205000000 240206000000 240207000000 240208000000 240209000000
##          11           9           5          17          14          10
## 240210000000 240211000000 240212000000 240213000000 240214000000 240215000000
##          15          13           7          11           7          10
## 240216000000 240217000000 240218000000 240219000000 240220000000 240221000000
##          11           9          11          17          13           9
## 240222000000 240223000000 240224000000 240225000000 240226000000 240227000000
##          10           4          13           8          19           8
## 240228000000 240229000000 240301000000 240302000000 240303000000 240304000000
##          11           8           7          12          10           9
## 240305000000 240306000000 240307000000 240308000000 240309000000 240310000000
##           3          10           2           3           3           1
## 240311000000 240312000000 240313000000 240314000000 240315000000 240316000000
##           7           4          10          12          12          11
## 240317000000 240318000000 240319000000 240320000000 240321000000 240322000000
##          12           7           9           9          14           6
## 240323000000 240324000000 240325000000 240326000000 240327000000 240328000000
##           7           5           6          16           8           5
## 240329000000 240330000000 240331000000 240401000000 240402000000 240403000000
##           2           3          12          11           8           7
## 240404000000 240405000000 240406000000 240407000000 240408000000 240409000000
##           4           7          11           7           5           7
## 240410000000 240411000000 240412000000 240413000000 240414000000 240415000000
##          20           9           6           5           8           9
## 240416000000 240417000000 240418000000 240419000000 240420000000 240421000000
```

```
##            8           10            9            5           10            8
## 240422000000 240423000000 240424000000 240425000000 240426000000 240427000000
##            5           20            7           16            7            9
## 240428000000 240429000000 240430000000 240501000000 240502000000 240503000000
##           19           12            5            6           15            7
## 240504000000 240505000000 240506000000 240507000000 240508000000 240509000000
##            9           14            9           16            7            6
## 240510000000 240511000000 240512000000 240513000000 240514000000 240515000000
##            5           10            9           10           11            9
## 240516000000 240517000000 240518000000 240519000000 240520000000 240521000000
##            7            9            7            7           12           10
## 240522000000 240523000000 240524000000 240525000000 240526000000 240527000000
##           16            8           10           12            9           13
## 240528000000 240529000000 240530000000 240531000000 240601000000 240602000000
##           10           11           16            9            8            3
## 240603000000 240604000000 240605000000 240606000000 240607000000 240608000000
##           11            9           13           11           10           15
## 240609000000 240610000000 240611000000 240612000000 240613000000 240614000000
##            7           15           13           12           12            9
## 240615000000 240616000000 240617000000 240618000000 240619000000 240620000000
##            9            6           11            3            7           16
## 240621000000 240622000000 240623000000 240624000000 240625000000 240626000000
##           12           13           12           11            9           11
## 240627000000 240628000000 240629000000 240630000000 240701000000 240702000000
##            9           11            4            8            8           10
## 240703000000 240704000000 240705000000 240706000000 240707000000 240708000000
##           12           11            3            6            2            8
## 240709000000 240710000000 240711000000 240712000000 240713000000 240714000000
##           14           10           20           12            7            4
## 240715000000 240716000000 240717000000 240718000000 240719000000 240720000000
##            8            5           10            8            2            1
## 240721000000 240722000000 240723000000 240724000000 240725000000 240726000000
##            8           18           13           13           14           10
## 240727000000 240728000000 240729000000 240730000000 240731000000 240801000000
##            9            5            8            6           10            8
## 240802000000 240803000000 240804000000 240805000000 240808000000 240810000000
##            5            4            7           11            1            2
## 240812000000 240813000000 240814000000 240815000000 240816000000 240817000000
##            2           28           11           14           15           17
## 240818000000 240819000000 240820000000 240821000000 240822000000 240823000000
##            7           15           14           12           19           16
## 240824000000 240825000000 240826000000 240827000000 240828000000 240829000000
##            6           11           14           12           18           17
## 240830000000 240831000000 240901000000 240902000000 240903000000 240904000000
##           10           12           25           22           18           21
## 240905000000 240906000000 240907000000 240908000000 240909000000 240910000000
##           23            6           25           21           17            7
## 240911000000 240912000000 240913000000 240914000000 240915000000 240916000000
##           24           23           14           17           19           20
## 240917000000 240918000000 240919000000 240920000000 240921000000 240922000000
##           20            9           17           15           13           15
## 240923000000 240924000000 240925000000 240926000000 240927000000 240928000000
##           16           19           22           10           11           12
## 240929000000 240930000000 241001000000 241002000000 241003000000 241004000000
```

```
##           19           17            8           18           11           11
## 241005000000 241006000000 241007000000 241008000000 241009000000 241010000000
##           11           15           13            8            5            9
## 241011000000 241012000000 241013000000 241014000000 241015000000 241016000000
##           10           16            9            9            7           10
## 241017000000 241018000000 241019000000 241020000000 241021000000 241022000000
##            9            9           12            7           15           13
## 241023000000 241024000000 241025000000 241026000000 241027000000 241028000000
##           16           14           15           16           16           11
## 241029000000 241030000000 241031000000 241101000000 241102000000 241103000000
##           16           12           22           17           12           14
## 241104000000 241105000000 241106000000 241107000000 241108000000 241109000000
##           10           17           15            6           10           14
## 241110000000 241111000000 241112000000 241113000000 241114000000 241115000000
##           12           19           11           13            9           10
## 241116000000 241117000000 241118000000 241119000000 241120000000 241125000000
##            9           11           18            9            8           11
## 241126000000 241127000000 241128000000 241129000000 241130000000 241201000000
##           18           19            8           12           13            9
## 241202000000 241203000000 241204000000 241205000000 241206000000 241207000000
##            6           11           11            2           12            9
## 241208000000 241209000000 241210000000 241211000000 241212000000 241213000000
##           13           14            6           10            3            6
## 241214000000 241215000000 241216000000 241217000000 241218000000 241219000000
##           11            6            9            4            6            2
## 241220000000 241221000000 241222000000 241223000000 241224000000 241225000000
##            4            5            6            8            2            5
## 241226000000 241227000000 241228000000 241229000000 241231000000 250101000000
##            5            4            2            3            1            6
## 250103000000 250104000000 250105000000 250106000000 250107000000 250108000000
##            6            9            8           11           24           13
## 250109000000 250110000000 250111000000 250112000000 250113000000 250114000000
##           17           25           14            9           12           18
## 250115000000 250116000000 250117000000 250118000000 250119000000 250120000000
##            8           16           21           17           26           10
## 250121000000 250122000000 250123000000 250124000000 250125000000 250126000000
##           20           17           19           12           22           16
## 250127000000 250128000000 250129000000 250130000000 250131000000 250201000000
##           14            8           11           17           24           16
## 250202000000 250203000000 250204000000 250205000000 250206000000 250207000000
##           12           18            6           14           14           15
## 250208000000 250209000000 250210000000 250211000000 250212000000 250213000000
##           10            5           15           14           11           13
## 250214000000 250215000000 250216000000 250217000000 250218000000 250219000000
##           10           17           21           15           14           14
## 250220000000 250221000000 250222000000 250223000000 250224000000 250225000000
##           14           10            2            5           18            8
## 250226000000 250227000000 250228000000 250301000000 250302000000 250303000000
##           17            8           12            9            9           14
## 250304000000 250305000000 250306000000 250307000000 250308000000 250309000000
##            1           14           14           11            3            7
## 250310000000 250311000000 250312000000 250313000000 250314000000 250315000000
##           16           14           18           13            5           12
## 250316000000 250317000000 250318000000 250319000000 250320000000 250321000000
```

```
##           19            6           18           19           12            9
## 250322000000 250323000000 250324000000 250325000000 250326000000 250327000000
##            8           13           10            5           10           13
## 250328000000 250329000000 250330000000 250331000000 250401000000 250402000000
##            9           14           11           13           18            7
## 250403000000 250404000000 250405000000 250406000000 250407000000 250408000000
##            7           15           19           12           12           17
## 250409000000 250410000000 250411000000 250412000000 250413000000 250414000000
##            9           16           24           15           13           15
## 250415000000 250416000000 250417000000 250418000000 250419000000 250420000000
##            8           11           13            8            6           11
## 250421000000 250422000000 250423000000 250424000000 250425000000 250426000000
##           13           15            8            9            2            9
## 250427000000 250428000000 250429000000 250430000000 250501000000 250502000000
##           12           17           17           17           13           12
## 250503000000 250504000000 250505000000 250506000000 250507000000 250508000000
##           15           13           21           14           10            6
## 250509000000 250510000000 250511000000 250512000000 250513000000 250514000000
##            8           10           12           14           13           13
## 250515000000 250516000000 250517000000 250518000000 250519000000 250520000000
##           12           11           16           15            8            4
## 250521000000 250522000000 250523000000 250524000000 250525000000 250526000000
##            7            9            3            9            2            3
## 250527000000 250528000000 250529000000 250530000000 250531000000 250601000000
##            7            7            6            5            4            6
## 250602000000 250603000000 250604000000 250605000000 250606000000 250607000000
##            5            3            4            5            2            1
## 250608000000 250609000000 250610000000 250611000000 250612000000 250613000000
##            2            3            4            3            1            2
## 250614000000 250615000000 250616000000 250617000000 250619000000 250620000000
##            2            2            1            1            1            4
## 250621000000 250622000000 250624000000 250626000000 250628000000 250630000000
##            2            1            1            1            1            2
## 250704000000 250711000000
##            1            1
```

```
student_performance$task_rating <- round(student_performance$Awarded /
      (student_performance$Awarded + student_performance$Rejected), 2)

student_performance$training_rating <- round(student_performance$Completed /
      (student_performance$Incomplete + student_performance$Participated +
         student_performance$Withdrawn + student_performance$Completed), 2)
```

```
str(student_performance)
```

```
## 'data.frame':    10139 obs. of  16 variables:
##  $ TumoID               : num  240712000018 240924000012 230619000016 230121000032 250415000009 ...
##  $ Age                  : int  14 13 14 14 13 13 13 15 20 14 ...
##  $ Classification       : chr  "T" "T" "M" "M" ...
##  $ Schedule             : chr  "Sunday 13:30" "Monday 17:30" "Sunday 13:30" "Tuesday 19:30" ...
##  $ Status               : chr  "Active" "Preclosed" "Active" "Active" ...
##  $ RetentionGrouped     : chr  "0.5 - 1 Year" "0.1 - 0.5 Year" "1.5 - 2 Year" "2 - 2.5 Year" ...
##  $ Awarded              : int  38 8 36 35 12 13 19 20 22 52 ...
```

```
##  $ Rejected              : int  6 0 4 2 4 2 1 3 0 1 ...
##  $ Completed             : int  1 0 5 4 0 0 1 2 0 6 ...
##  $ Incomplete            : int  0 0 0 2 0 0 0 0 0 1 ...
##  $ Participated          : int  0 0 0 0 0 1 2 0 0 0 ...
##  $ Withdrawn             : int  0 0 0 2 0 0 0 0 1 1 ...
##  $ LearningLabs.Completed: int  0 0 1 2 0 0 0 0 0 0 ...
##  $ AttendingSince        : chr  "10/10/2024" "2/10/2025" "12/7/2023" "6/6/2023" ...
##  $ task_rating           : num  0.86 1 0.9 0.95 0.75 0.87 0.95 0.87 1 0.98 ...
##  $ training_rating       : num  1 NaN 1 0.5 NaN 0 0.33 1 0 0.75 ...
```

```
table(student_performance$task_rating)
```

```
##
## 0.36  0.5 0.52 0.53 0.54 0.57 0.58 0.59  0.6 0.61 0.62 0.63 0.64 0.65 0.67 0.68
##    1    1    1    1    2    4    4    2    4    1    6    4    6   17   14   14
## 0.69  0.7 0.71 0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79  0.8 0.81 0.82 0.83 0.84
##   23   21   30   23   28   38   53   54   57   77   96   89  108  128  144  113
## 0.85 0.86 0.87 0.88 0.89  0.9 0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99    1
##  182  236  167  352  331  392  384  472  534  631  727  776  793  682  150 2166
```

```
table(student_performance$training_rating)
```

```
##
##    0 0.08 0.09  0.1 0.11 0.12 0.13 0.14 0.17 0.18  0.2 0.21 0.22 0.23 0.25 0.27
##  946    6    5    4    8   17    1   27   38    9   75    3   17    6  190    7
## 0.28 0.29  0.3 0.31 0.32 0.33 0.35 0.36 0.37 0.38 0.39  0.4 0.41 0.42 0.43 0.44
##    1   61   26    4    2  365    2   20    1   54    2  181    2   11   68   42
## 0.45 0.46 0.47 0.48  0.5 0.52 0.53 0.54 0.55 0.56 0.57 0.58 0.59  0.6 0.62 0.64
##   20    9    7    1 1012    3    6   11   27   52  114   25    2  252  117   32
## 0.65 0.67 0.68 0.69  0.7 0.71 0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79  0.8 0.81
##    3  754    2   14   55  156    2   35    1  483    6   15   49   13  320    4
## 0.82 0.83 0.84 0.85 0.86 0.87 0.88 0.89  0.9 0.91 0.92 0.93 0.94 0.95 0.96    1
##   23  233    1    9  143    6  108   56   38   17   13    8    4    1    1 2520
```

Hypothesis 1: Attendance correlates with student performance

Assumption: Students with higher attendance are more likely to perform better (complete courses) compared to students with low attendance.

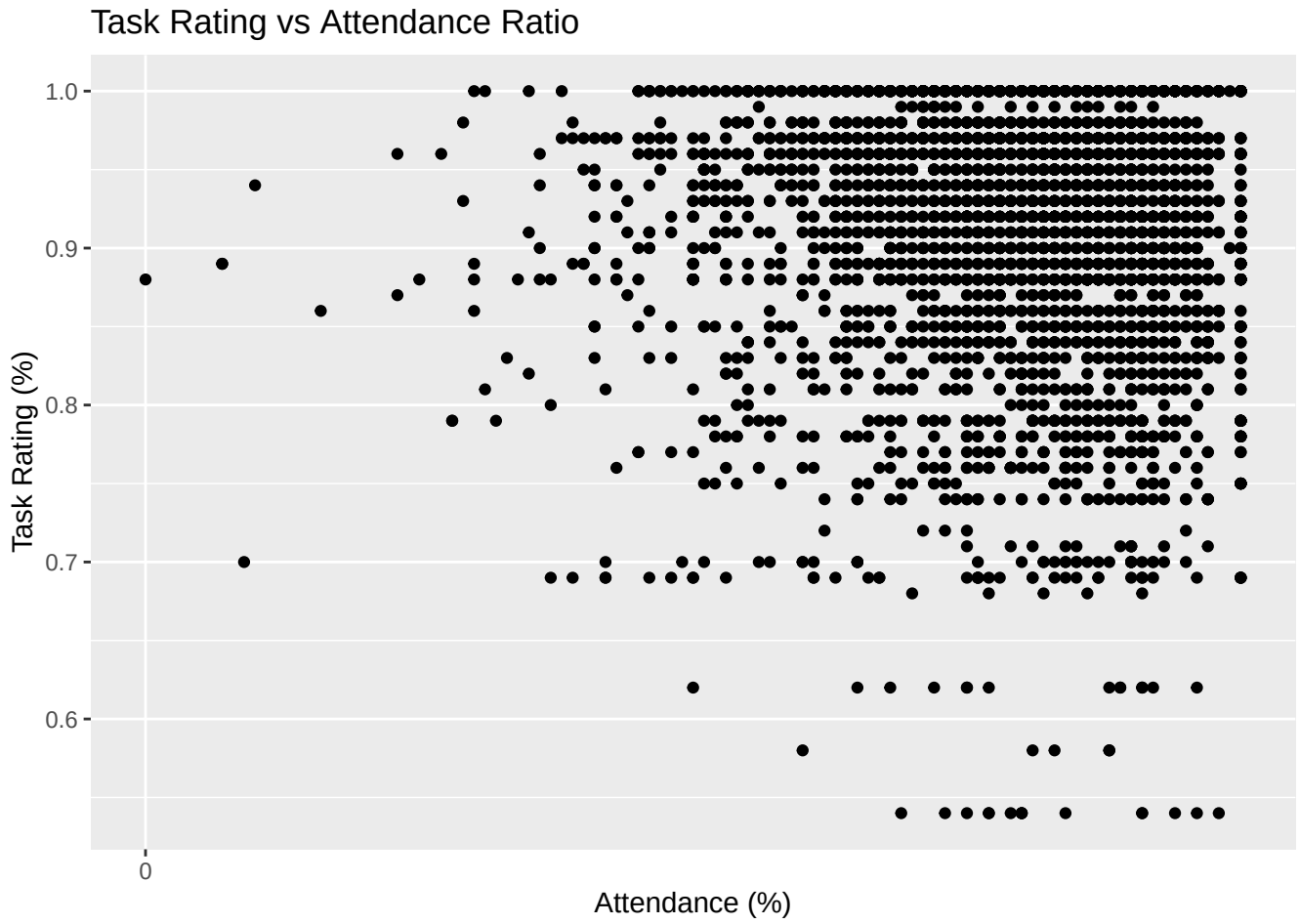
Rationale: Students who are actively attending classes may engage more with the material, leading to better performance.

```
merged_df <- inner_join(student_info, student_performance, by = "TumoID")
```

```
merged_df$PresenceRatio <- round(as.integer(merged_df$PresenceRatio) / 100, 2)
```

```
ggplot(merged_df, aes(x = PresenceRatio, y = task_rating)) +
  geom_point() +
  labs(
    title = "Task Rating vs Attendance Ratio",
```

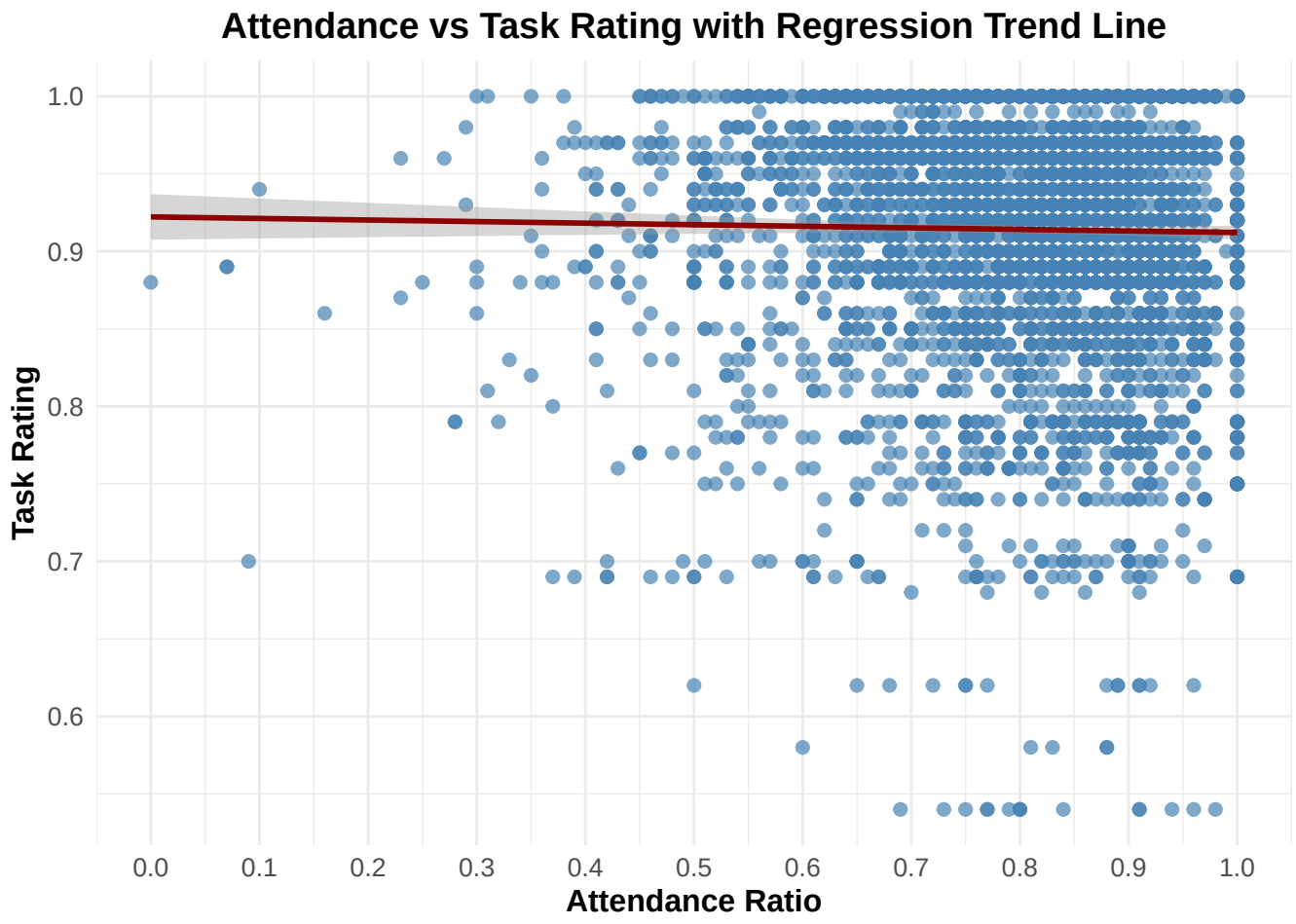
```
    x = "Attendance (%)",
    y = "Task Rating (%)"
  ) +
  scale_x_continuous(breaks = seq(0, 100, 10))
```



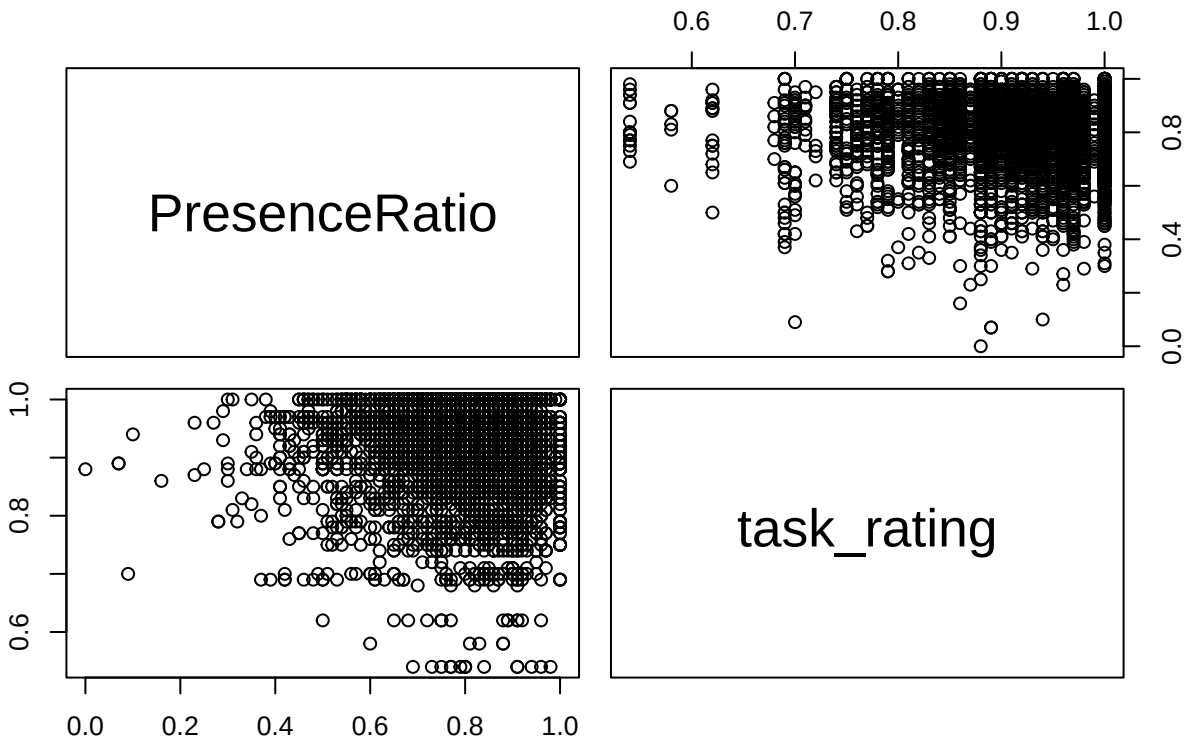
Scatterplot: Presence Rate & Task Rating Trend

```
ggplot(merged_df, aes(x = PresenceRatio, y = task_rating)) +
  geom_point(color = "steelblue", size = 2, alpha = 0.7) +                    # points
  geom_smooth(method = "lm", se = TRUE, color = "darkred", linewidth = 1) +   # trend line with CI
  labs(
    title = "Attendance vs Task Rating with Regression Trend Line",
    x = "Attendance Ratio",
    y = "Task Rating"
  ) +
  scale_x_continuous(breaks = seq(0, 1, 0.1)) +                               # ticks every 0.1
  theme_minimal() +
  theme(
    plot.title = element_text(hjust = 0.5, face = "bold", size = 14),
```

```
    axis.title = element_text(face = "bold", size = 12),
    axis.text = element_text(size = 10)
  )
```




```
pairs(merged_df[, c("PresenceRatio", "task_rating")],
      main = "Scatterplot Matrix")
```



Linear Relationship: Presence Rate VS Task Rating

```
spearman_cor_test_result <- cor.test(merged_df$PresenceRatio, merged_df$task_rating,
                          method = "spearman", exact = FALSE, use = "complete.obs")
spearman_cor_test_result
```

```
##
##  Spearman's rank correlation rho
##
## data:  merged_df$PresenceRatio and merged_df$task_rating
## S = 13193615048, p-value = 0.0003643
## alternative hypothesis: true rho is not equal to 0
## sample estimates:
##         rho
## -0.05486129
```

Monotonicity: Presence Rate VS Task Rating

```r
pearson_cor_test_result <- cor.test(merged_df$PresenceRatio, merged_df$task_rating,
                            method = "pearson", exact = FALSE, use = "complete.obs")
pearson_cor_test_result
```

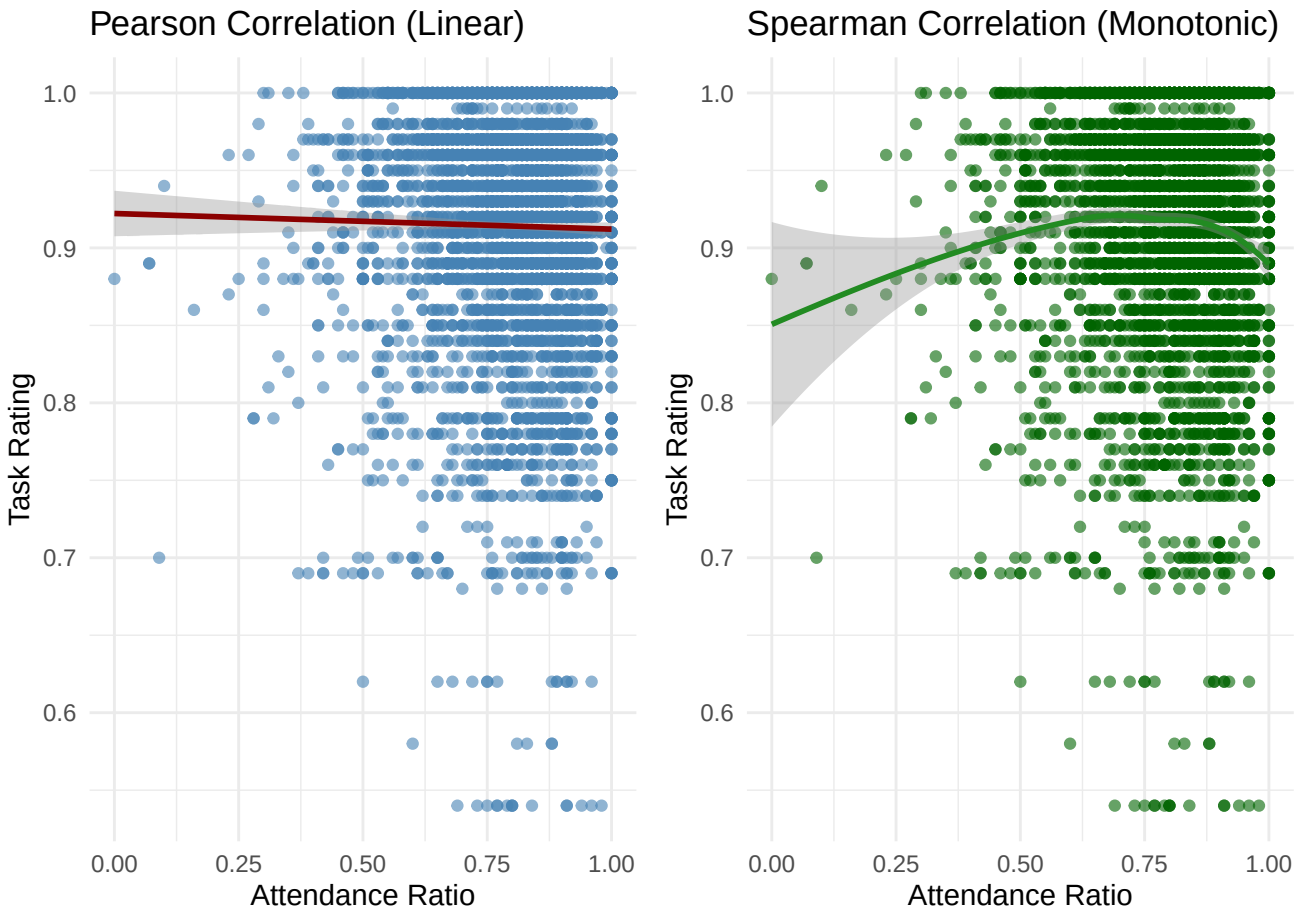
```
##
##  Pearson's product-moment correlation
##
## data:  merged_df$PresenceRatio and merged_df$task_rating
## t = -1.0881, df = 4216, p-value = 0.2766
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.04691147  0.01343134
## sample estimates:
##         cor
## -0.01675532
```

Linearity and Monotonicity Plots

```r
p1 <- ggplot(merged_df, aes(x = PresenceRatio, y = task_rating)) +
  geom_point(alpha = 0.6, color = "steelblue") +
  geom_smooth(method = "lm", se = TRUE, color = "darkred") +
  labs(title = "Pearson Correlation (Linear)",
       x = "Attendance Ratio",
       y = "Task Rating") +
  theme_minimal()

# Spearman scatterplot with loess smooth (captures monotonic relationship)
p2 <- ggplot(merged_df, aes(x = PresenceRatio, y = task_rating)) +
  geom_point(alpha = 0.6, color = "darkgreen") +
  geom_smooth(method = "loess", se = TRUE, color = "forestgreen") +
  labs(title = "Spearman Correlation (Monotonic)",
       x = "Attendance Ratio",
       y = "Task Rating") +
  theme_minimal()

p1 + p2
```



Hypothesis 2: Number of courses started impacts performance outcomes

Assumption: Students who start more courses may either demonstrate strong engagement or be overwhelmed, which could lead to different performance outcomes (completed, failed, or withdrawn).

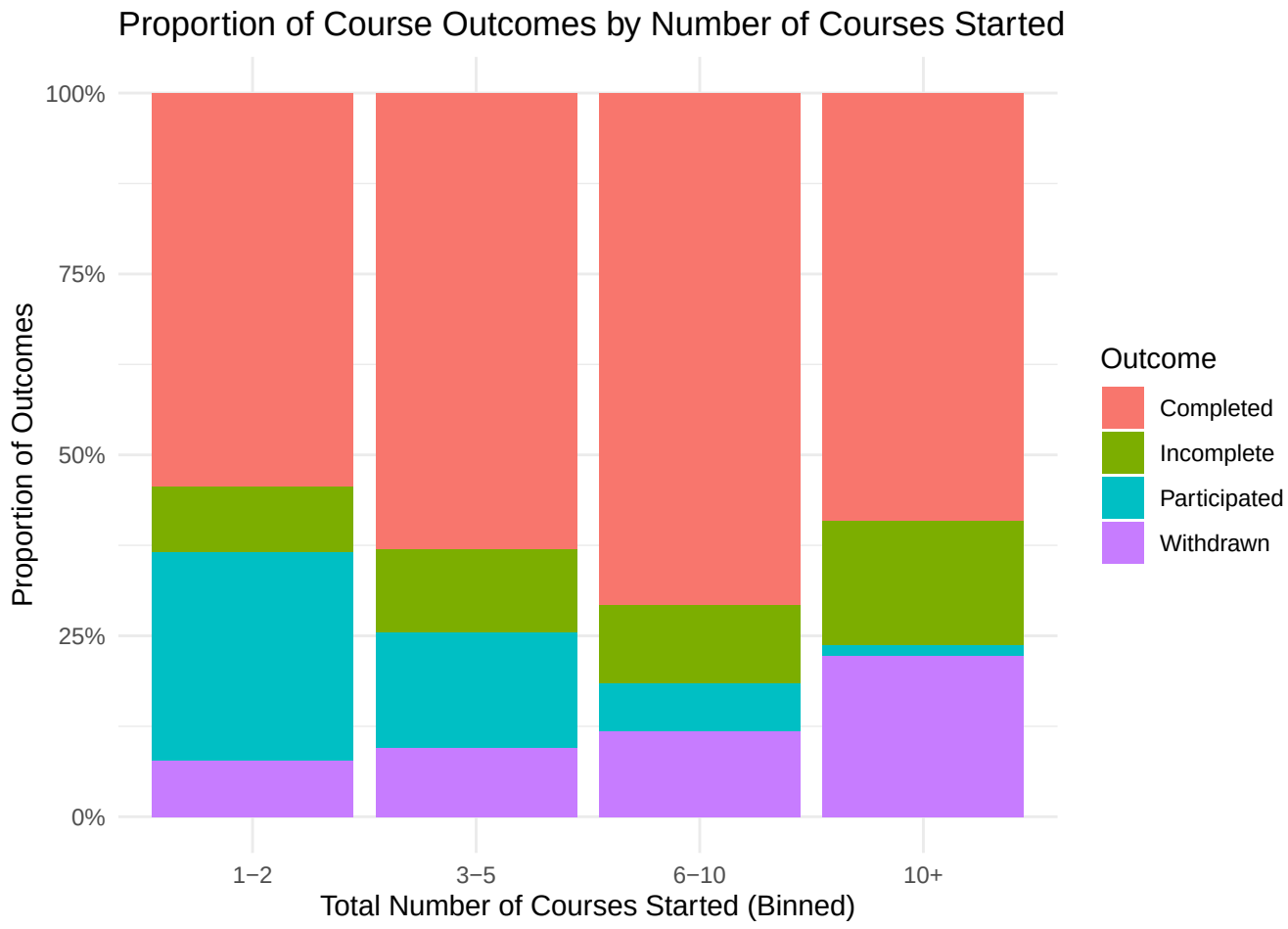
Rationale: Engaging with multiple courses may indicate either strong motivation or poor focus/time management skills, both of which could affect performance outcomes.

```
course_outcomes <- merged_df %>%
  mutate(total_courses = Completed + Incomplete + Participated + Withdrawn) %>%
  pivot_longer(
    cols = c(Completed, Incomplete, Participated, Withdrawn),
    names_to = "Outcome",
    values_to = "Count"
  )
```

Proportion of Course Outcomes by Number of Courses Started

```
course_outcomes <- course_outcomes %>%
  mutate(total_bin = cut(total_courses, breaks = c(0, 2, 5, 10, Inf),
                         labels = c("1-2", "3-5", "6-10", "10+"), right = FALSE))

ggplot(course_outcomes, aes(x = total_bin, y = Count, fill = Outcome)) +
  geom_bar(stat = "identity", position = "fill") +
  scale_y_continuous(labels = percent_format()) +
  labs(
    title = "Proportion of Course Outcomes by Number of Courses Started",
    x = "Total Number of Courses Started (Binned)",
    y = "Proportion of Outcomes",
    fill = "Outcome"
  ) +
  theme_minimal()
```




```
df <- merged_df %>%
  mutate(
    total_courses = Completed + Participated + Rejected + Withdrawn,
```

```
    course_volume_group = cut(
      total_courses,
      breaks = c(-Inf, 2, 5, 10, Inf),
      labels = c("1-2", "3-5", "6-10", "10+")
    )
  )

outcome_table <- df %>%
  group_by(course_volume_group) %>%
  summarise(
    Completed = sum(Completed, na.rm = TRUE),
    Participated = sum(Participated, na.rm = TRUE),
    Failed = sum(Rejected, na.rm = TRUE),
    Withdrawn = sum(Withdrawn, na.rm = TRUE)
  )
```

```
outcome_matrix <- as.matrix(outcome_table[, -1])
rownames(outcome_matrix) <- outcome_table$course_volume_group
chisq_result <- chisq.test(outcome_matrix)
```

```
outcome_matrix
```

```
##      Completed Participated Failed Withdrawn
## 1-2        428          128    644        56
## 3-5       2355          557   2685       406
## 6-10      4782          746   5227       865
## 10+       2266           38   1568       631
```

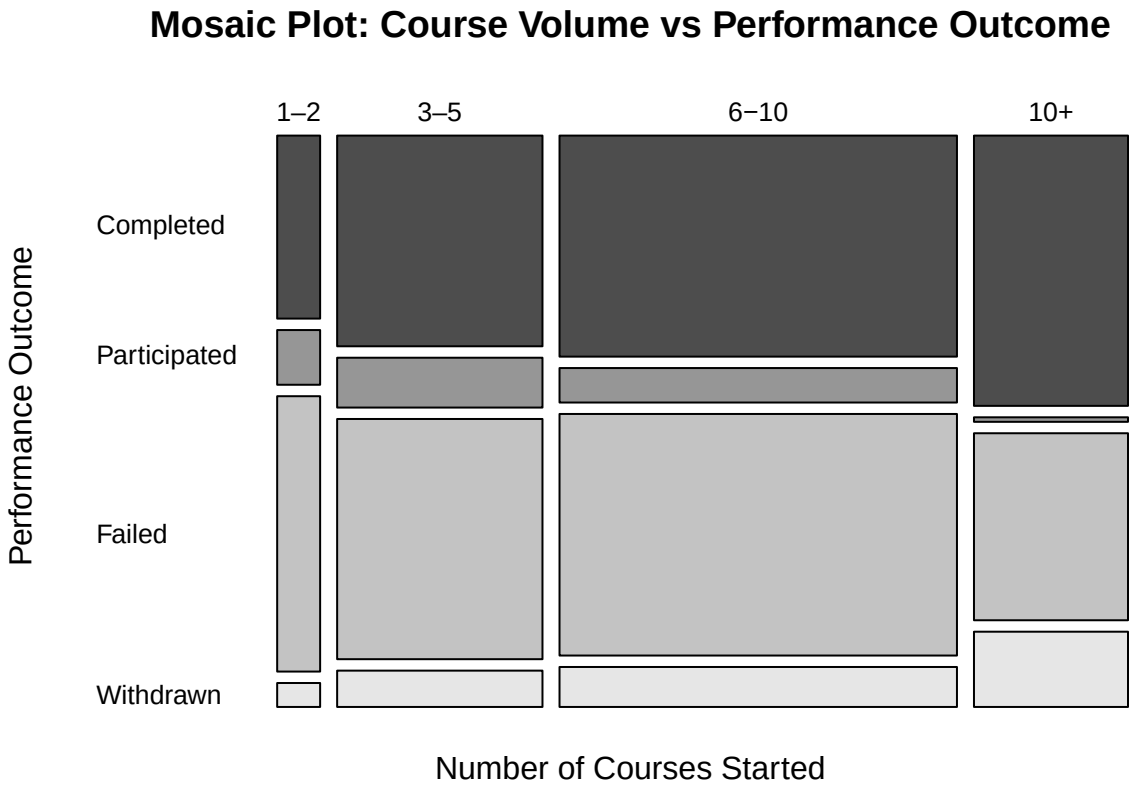
Variable Independence Test

```
chisq_result
```

```
##
##  Pearson's Chi-squared test
##
## data:  outcome_matrix
## X-squared = 762.73, df = 9, p-value < 0.00000000000000022
```

Course Volume VS Performance Outcome

```
mosaicplot(outcome_matrix,
           main = "Mosaic Plot: Course Volume vs Performance Outcome",
           color = TRUE,
           xlab = "Number of Courses Started",
           ylab = "Performance Outcome",
           las = 1,
           cex.axis = 0.8)
```



Hypothesis 3: Withdrawn students show different behavioral patterns than those who fail or complete courses.

Assumption: They have distinct engagement traits (e.g., lower attendance or fewer tasks completed).

Rationale: Withdrawals may stem from personal or motivational issues, reflected in measurable behavior.

```
merged_df$main_outcome_group <- case_when(
  merged_df$Withdrawn > 0 ~ "Withdrawn",
  merged_df$Completed > 0 ~ "Completed",
  merged_df$Rejected > 0 ~ "Failed",
  TRUE ~ "Other"
)
```

T-Test: Withdrawn vs Completed

```
t.test(PresenceRatio ~ main_outcome_group,
       data = merged_df %>% filter(main_outcome_group %in% c("Withdrawn", "Completed")))
```

```
##
##  Welch Two Sample t-test
##
## data:  PresenceRatio by main_outcome_group
## t = 6.3982, df = 2091.9, p-value = 0.0000000001934
## alternative hypothesis: true difference in means between group Completed and group Withdrawn is not
## 95 percent confidence interval:
##  0.02077441 0.03913800
## sample estimates:
## mean in group Completed mean in group Withdrawn
##               0.8026398               0.7726836
```

T-Test: Withdrawn vs Failed

```
t.test(PresenceRatio ~ main_outcome_group,
       data = merged_df %>% filter(main_outcome_group %in% c("Withdrawn", "Failed")))
```

```
##
##  Welch Two Sample t-test
##
## data:  PresenceRatio by main_outcome_group
## t = 5.8457, df = 1558.9, p-value = 0.000000006131
## alternative hypothesis: true difference in means between group Failed and group Withdrawn is not equa
## 95 percent confidence interval:
##  0.02520169 0.05065455
## sample estimates:
##    mean in group Failed mean in group Withdrawn
##               0.8106117               0.7726836
```

Principal Component Analysis (PCA)

Understanding PCA

Principal Component Analysis (PCA) reduces high-dimensional data into fewer dimensions by transforming correlated variables into uncorrelated components, where each component captures the **maximum possible variance** in the data.

```
df_numeric <- merged_df %>%
  select(where(is.numeric)) %>%
  na.omit()

groups <- merged_df %>%
  filter(complete.cases(select(., where(is.numeric)))) %>%
  pull(main_outcome_group)
```

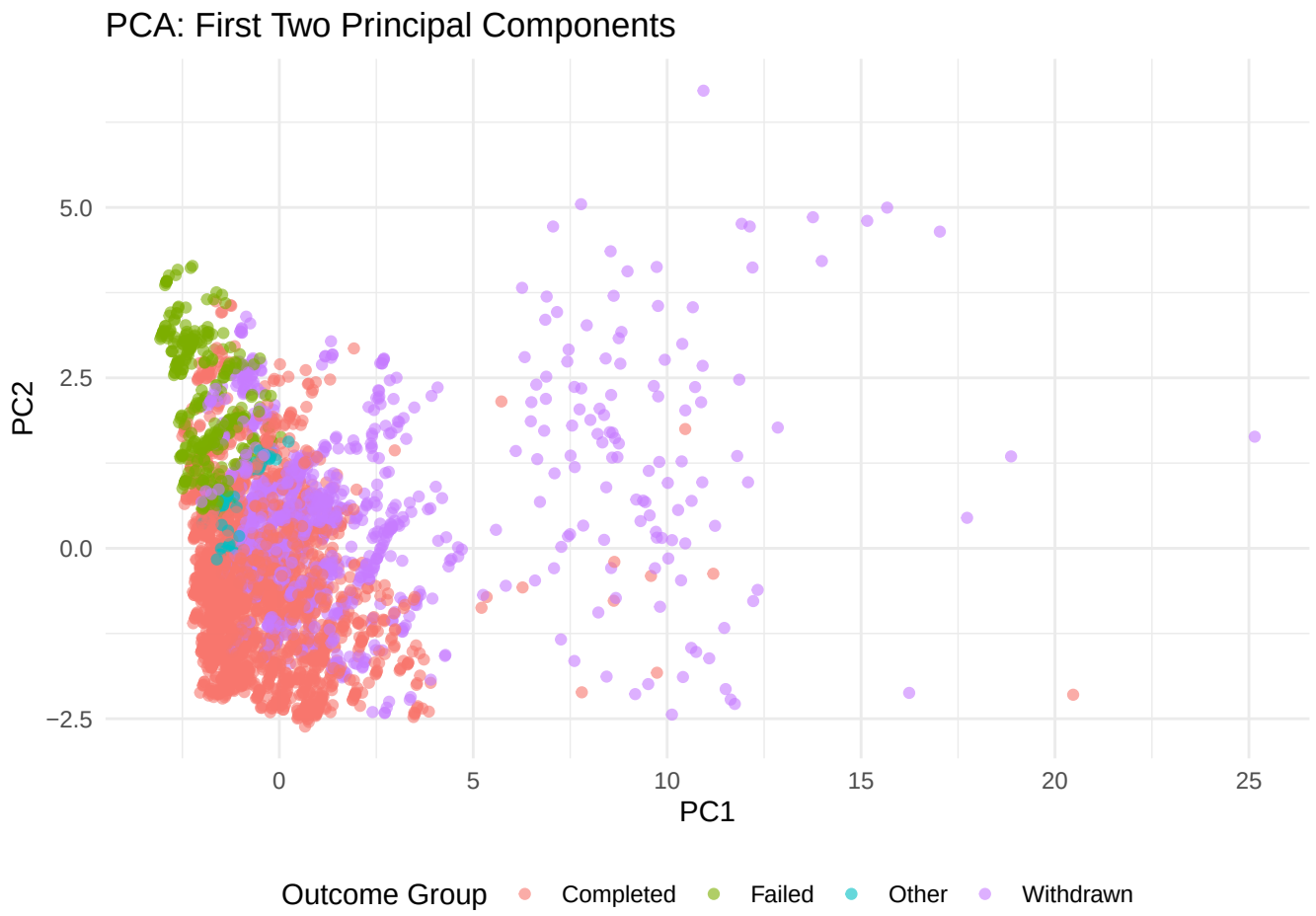
```
pca_result <- prcomp(df_numeric, center = TRUE, scale. = TRUE)

pca_df <- as.data.frame(pca_result$x)
pca_df$Group <- groups
```

We use prcomp() with centering and scaling to ensure equal weighting across features.

PCA Plot: First Two Principal Components

```
ggplot(pca_df, aes(x = PC1, y = PC2, color = Group)) +
  geom_point(alpha = 0.6, size = 1.5) +
  labs(title = "PCA: First Two Principal Components",
       color = "Outcome Group") +
  theme_minimal() +
  theme(legend.position = "bottom")
```



If Withdrawn points cluster separately from Completed or Failed, this supports the hypothesis: withdrawn students behave differently.