Teamwork Interest Differences Between Face-to-Face and Online Students

Abdullah Konak and Sadan Kulturel-Konak
Penn State Berks

Abstract

In the current decade, there are two prevailing trends in STEM education, the rise of online education and the integration of the 21st century skills into technical curricula. Online education is the fastest growing segment of the US education sector. Particularly in STEM programs, there is a need for preparing students for increasingly complex work environments in the 21st century. Teamwork has been a norm in many programs to improve students' professional skills. Although online education has significantly grown, only limited research addresses the effectiveness of teamwork in online settings. This paper focuses on investigating differences in online and face-to-face students' interest in teamwork. Interest in a domain is an important construct indicating how much learners are willing to exert effort to learn about the domain. Therefore, interest can be used as an assessment metric to evaluate students' professional skills development.

I. Introduction

Solving the complex problems of the modern society requires multi-disciplinary approaches grounded in knowledge and skills from many disciplines, including non-engineering ones. Multi-disciplinary teams bring together knowledge, background, and expertise, which cannot be embodied in a single person. Therefore, multi-disciplinary problem solving teams have been an important part of the contemporary organizational culture today. However, analyzing a problem with a multi-disciplinary perspective demands more than putting together a team of members from various disciplines and backgrounds. The multi-disciplinary nature of a team does not guarantee successful team performance. The research shows that the performance of a team depends on how effectively team members are able to share information, assign tasks based on the strengths of team members, coordinate tasks, and provide feedback to one another.[1] For example, the high failure rate observed in information technology (IT) projects has been attributed to the lack of professional skills in project teams, but not to technical deficiencies in these teams.[2,3] Therefore, educating our graduates as effective team members is as important as providing them with advance technical knowledge and skills.

In the last two decades, academic institutions have put significant efforts toward enhancing their curricula for providing their students with teamwork skills along with technical ones. As a result, teamwork has become very common in engineering and technology programs. The accreditation boards, such as the Accreditation Board of Engineering and Technology (ABET), also require evidences that students are actually acquiring teamwork skills. However, the assessment of teamwork skills like all professional skills is challenging. Unlike technical skills, which can be acquired and assessed discretely, intellectual and social abilities of students slowly mature throughout their education.[4,5,6] In our earlier work, for example, we have identified that teamwork skills and awareness in engineering students leap after the third year, specifically

when they are involved in internships or capstone design experiences.[4] Furthermore, teamwork skills are personal and highly subjective.

In the last decade, online education has been steadily expanding. The number of students taking at least one online course increased from 1.6 million in 2002 to 7.1 million in Fall 2012, representing annual growth rate of 16.1 percent, according to a survey report[5] periodically published by Bobson Survey Research Group to track the state of online education in the US. In the same report, the majority of higher institutions also identify online education as a critical component of their long-term growth strategies. Expansion of online education has brought new challenges for teaching and assessing professional skills. The lack of face-to-face communication might be the most important challenge for teamwork in online courses. These challenges can cause negative attitudes in students toward teamwork in online settings. Although both face-to-face and online students can exhibit negative attitude toward teamwork, several papers[6,7, 8, 9,10] report a lower satisfaction of teamwork among online students than face-to-face students. In a study[6] involving IT students, for example, we found that online students exhibited more negative attitude toward teamwork than face-to-face students did. In another study[11] about an online cyber security course, students rated group work activities among the least favored parts of the course.

In this paper, we investigate and compare face-to-face and online students' interest in developing their teamwork skills. When students are interested in the subject matter, they tend to process the information more efficiently and use more effective strategies that lead to deeper learning. Interest is also an important construct for identifying students' career choices. In a longitudinal study[12], for example, interest predicted the likelihood of students' majoring in psychology more accurately than their academic performance in an introductory psychology course. Interest is also shown[8] to have a strong correlation with academic achievement and professional experience of engineering students. In this paper, we mainly focus on individual interest, which is the long lasting interest that motivates learners to be proficient in a domain. Our primary goal is to investigate the validity of interest as a new construct to evaluate students' development in teamwork proficiency. Our main hypothesis is that interest can predict students' proficiency in teamwork regardless of face-to-face or online education. Because majority of online students are non-traditional students with real-life professional experience, comparing their teamwork interest and attitude to those of face-to-face students can provide important insight in this respect. Our research questions are as follows:

- Can interest be used to assess teamwork skills and proficiency?
- Is there any difference between face-to-face and online students in terms of their interest in developing their teamwork skills?
- What are the factors affecting students' levels of interest in developing teamwork skills?
- Is there any difference between the attitudes of online and face-to-face students toward teamwork?

II. Background

The research in this paper is built upon the foundation of the Model of Domain Learning (MDL) which was developed by Alexander and her colleagues.[14,15,16] MDL is a learning theory that aims to explain how a learner becomes an expert in a domain. According to MDL, a learner goes

through three progressive and incremental developmental stages, i.e., acclimation, competency and proficiency, while becoming an expert in a domain. MDL suggests that as learners have different types of domain specific knowledge, strategic processing abilities, and interest in the domain in each of these developmental stages. Thereby, the evidence of development is observed when learners demonstrate shifts along these three learning-based dimensions, i.e., knowledge, strategic processing, and interest, toward expertise. Therefore, MDL has been proposed[16] as a theoretical framework for assessing teamwork skills because of its validity of predicting the stages of student development.

In MDL, two types of interest are considered: individual and situational interest. Situational interest arises spontaneously due to external factors such as a new topic, an engaging text, or a movie clip. In the acclimation stage, the interest is situational interest, which means that learners show interest only due to an increased attention as a new topic is introduced. On the other hand, individual interest is the long lasting interest that motivates learners to acquire more knowledge in a domain. Learners are willing to immerse themselves into a topic and show increased commitment. Interest in the proficiency stage is an individual interest. According to MDL, deeper knowledge and strategic processing abilities in a domain leads to increased individual interest. Therefore, individual interest is also a precursor for sustaining long-term learning[17]. Empirical studies conducted by Alexander et al.[14] show that there are complex interactions between knowledge, interest, and strategic processing through which expertise is gained.

III. Research Methodology

We designed a survey instrument to measure interest and some other related variables, and the survey was emailed to information technology students at a university with multiple campuses. The responses to the survey were analyzed to answer the research questions.

Description of the Instrument

The instrument has two types of interest questions. The first group of questions intends to measure how frequently students engaged in learning activities related to teamwork (Engagement Interest). These questions are operationalized using four-level Likert scales (1=None, 2=Once, 3=A few times (2-3), 4= Several times or more (>4)). The questions in this group are given as follows:

- Attended a speaker event about teamwork
- Watched a documentary or training video about teamwork
- Watched a video clip outside of class work about teamwork
- Attended a workshop about teamwork
- Asked questions to an expert (professor, consultant etc.) about effective teamwork
- Performed a web search to learn about effective teamwork
- Read a book about teamwork

The second group of questions aims to measure students' individual interest to improve their teamwork skills and abilities. These questions are also operationalized using four-level Likert scales (1=Very Uninterested/Unlikely, 2=Uninterested/Unlikely, 3=Interested/Likely, 4= Very Interested/ Very Likely). The questions in this group are given as follows:

- Rate your level of interest in attending a free workshop on teamwork.
- Rate your level of interest in reading literature about effective teamwork.

- While you are browsing a news website, you have spotted an article called “How to be Effective in Teamwork.” Rate your likelihood of reading this article.
- Rate your level of willingness to take an elective course in order to improve your teamwork skills.
- In your institution, a renowned teamwork guru will give a workshop on teamwork skills. If you have to pay $10 for this workshop, rate your level of interest in attending this workshop.

In addition to these interest questions, the instrument included questions to measure teamwork self-efficacy, attitude toward teamwork, and perception of importance of teamwork. As we discuss in the following section, these measures are used to control for individual differences among students.

To measure the overall attitude toward teamwork, the following Likert scales questions (1=Strongly Disagree, 2=Disagree, 3=Agree, 4= Strongly Agree) are used:

- I usually have a negative experience with teamwork (reverse coded)
- I would rather work on team projects than on my own
- I like to participate in teamwork
- I am usually motivated to participate in teamwork

In order to measure their teamwork self-efficacy, students are asked to rate themselves using four-level Likert scales (1= Very Unconfident, 2=Unconfident, 3=Confident, 4= Very confident) with respect to the following teamwork skill, knowledge, and abilities.

- Establishing specific team goals
- Evaluating team progress toward each team goal
- Providing feedback on the team or individual performance
- Accepting feedback and criticism positively
- Making adjustments based on the feedback
- Defining tasks and clear task expectations to achieve these team objectives
- Defining tasks sequences and inter-dependencies
- Defining and understanding team roles and role expectations
- Identifying team resources and team member skills
- Distributing workload in a fair and logical manner
- Coordinating and synchronizing tasks, information, and task inter-dependencies among team members
- Communicating effectively in a team setting
- Openly expressing ideas
- Giving feedback to others
- Using communication technologies skillfully to coordinate team tasks
- Listening to others effectively
- Understanding of the messages conveyed by the non-verbal behaviors
- Controlling non-verbal behaviors
- Recognizing and encouraging constructive and civil discussions in a team
- Recognizing undesirable conflict and understanding the source of undesirable conflict
- Maintaining team unity even when team members cannot compromise and negotiate a solution

- Employing win-win negotiation strategy when conflict arises
- Identifying problems requiring group problem solving
- Involving team members in decision making process
- Implementing proper group problem solving techniques for the problem at hand

To measure the relative importance of teamwork skills, students are asked to rate the relative importance of having teamwork skills with respect to the importance of the domain specific skills in order to be successful in their intended professional career (1=Not as important as the domain knowledge, 10=As important as the domain knowledge). Finally, the instrument included several background and demographical questions.

Participants

The survey instrument was emailed to students in a college, which has a strong online presence. After data cleaning, n=359 responses were used in this study. The distributions of the responses across various demographic metrics are presented in Table 1. The online group mainly includes non-traditional students (79.9%) whereas the face-to-face group is mainly consist of traditional students (78.6%). An overwhelming majority of online students have full-time jobs as expected. The distribution of the students in terms of gender, class standing, and GPA (dean list) are similar across the two groups with small variations.

Table 1. Background and demographical information of the participants.

		Face-to-Face (*n*=220)	Online (*n*=139)
Full-time Job (>40 hours)	No	87.2%	13.7%
	Yes	12.8%	86.3%
Veteran	No	86.8%	70.8%
	Yes	13.2%	29.2%
Non-traditional (age > 25)	No	78.6%	20.1%
	Yes	21.4%	79.9%
Gender:	Female	24.7%	22.8%
	Male	75.3%	77.2%
Dean List	No	58.8%	45.0%
	Yes	41.2%	55.0%
Student Organization	No	54.9%	79.5%
	Yes	45.1%	20.5%
Class Standing	First Year	29.2%	22.1%
	Second Year	22.7%	19.5%
	Third Year	19.6%	30.2%
	Fourth Year	28.5%	28.2%
Professional Society	No	96.8%	92.6%
	Yes	3.2%	7.4%
Minor	No	65.6%	89.0%
	Yes	34.4%	11.0%

IV. Statistical Analysis

For each participant, we calculated the Engagement Interest, Individual Interest, Attitude, and Self Efficacy scores by averaging the participant's ratings of the corresponding survey questions. The internal consistencies of Engagement Interest, Individual Interest, Attitude, and Self Efficacy variables were calculated using Cronbach's α. Table 2 presents the means and standard deviations of these variables across three factors used in the statistical analyses as well as their Cronbach's α values. In terms of class standing, we grouped participants into two levels as Lower (The First and Second Year) and Upper (The Third and Fourth Year) because teamwork interest development is expected to progress slowly. We also compared the variable means across the three factor using *t*-test. In the table, the means are indicated by asterisks and bold characters if they are significantly different (at $p < 0.05$) between the two levels of the factors.

Table 2. Mean and standard deviations (Std. Dev.) measured variables across the three factors.

Factor/ Levels		Engagement Interest (α=0.847)	Individual Interest (α=0.861)	Attitude (α=0.709)	Self Efficacy (α=0.956)	Relative Importance
Student Type						
Face-to-Face (0)	Mean	**1.509**	**2.196**	**2.776***	3.226	**8.059***
	Std. Dev.	0.551	0.689	0.600	0.450	1.907
Online (1)	Mean	**1.680***	**2.425***	**2.445**	3.286	**7.596**
	Std. Dev.	0.753	0.767	0.594	0.492	2.537
Class Standing						
Lower Level (0)	Mean	1.509	2.233	2.640	**3.176**	7.737
	Std. Dev.	0.574	0.702	0.611	0.466	2.183
Upper Level (1)	Mean	1.632	2.327	2.672	**3.311***	8.039
	Std. Dev.	0.686	0.746	0.625	0.457	2.151
Gender						
Female (0)	Mean	**1.378**	2.279	2.559	3.255	8.084
	Std. Dev.	0.463	0.692	0.602	0.451	2.137
Male (1)	Mean	**1.636***	2.278	2.683	3.248	7.822
	Std. Dev.	0.672	0.739	0.623	0.473	2.179

*The values in the same column and factor are significantly different at $p < 0.05$ in the two-sided test of means. Tests are adjusted using the Bonferroni correction.

In order to study the differences between the face-to-face and online students in terms of their Individual Interest and Engagement Interest as well as to understand the causes of any difference, we used Univariate Analysis of Variance (ANOVA). The ANOVA model was run for each independent variable using three factors, Student Type, Gender, and Class Standing, and three covariates, Attitude, Self-Efficacy, and Relative Importance. In the models, the covariates were used to control for the individual differences in perceptions and self-reported abilities of the students. Tables 3 and 4 present the outputs of the ANOVA models for independent variables, Individual Interest and Engagement Interest, respectively. In the tables, the regression coefficients (B) and Partial Eta Squared values are also provided to gauge the effect sizes of the independent variables on the dependent variables.

Table 3. ANOVA results for Individual Interest

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	B	Partial Eta Squared
Corrected Model	50.296a	10	5.030	12.347	0.000		0.248
Intercept	11.347	1	11.347	27.856	0.000	1.629	0.069
(1) Relative Importance	23.702	1	23.702	58.185	0.000	0.126	0.134
(2) Attitude	8.192	1	8.192	20.109	0.000	0.263	0.051
(3) Self Efficacy	3.885	1	3.885	9.538	0.002	-0.226	0.025
(4) Type	7.941	1	7.941	19.495	0.000	0.439	0.049
(5) Gender	0.022	1	0.022	0.054	0.817	-0.269	0.000
(6) Class Standing	0.158	1	0.158	0.388	0.533	-0.123	0.001
(4) x (5)	0.083	1	0.083	0.204	0.651	0.303	0.001
(4) x (6)	0.390	1	0.390	0.958	0.328	0.073	0.003
(5) x (6)	1.174	1	1.174	2.881	0.090	0.504	0.008
(4) x (5) x (6)	0.837	1	0.837	2.056	0.152	-0.461	0.005
Error	152.756	375	0.407				
Total	2210.714	386					
Corrected Total	203.052	385					

R Squared = .248 (Adjusted *R* Squared = .228), Lack of Fitness Test: *F*=1.230, *p*-value=0.337

Table 4. ANOVA Results for Engagement Interest

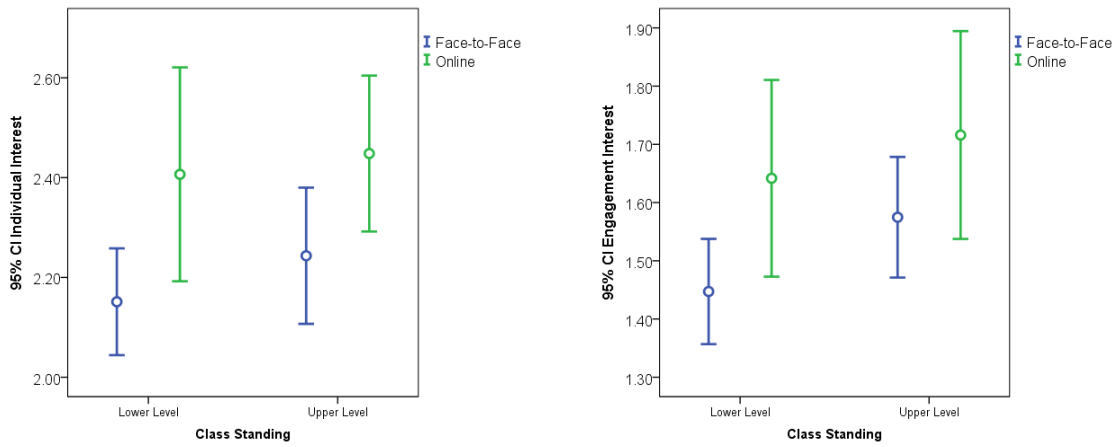
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	B	Partial Eta Squared
Corrected Model	24.652a	10	2.465	7.179	.000		.161
Intercept	.036	1	.036	.105	.746	0.405	.000
(1) Relative Importance	4.939	1	4.939	14.382	0.000	0.057	.037
(2) Attitude	1.175	1	1.175	3.421	0.065	0.100	.009
(3) Self Efficacy	3.835	1	3.835	11.168	0.001	0.224	.029
(4) Type	1.337	1	1.337	3.893	0.049	0.228	.010
(5) Gender	4.994	1	4.994	14.541	0.000	0.578	.037
(6) Class Standing	.087	1	.087	.254	0.614	0.120	.001
(4) x (5)	.645	1	.645	1.879	0.171	0.348	.005
(4) x (6)	.084	1	.084	.245	0.621	0.072	.001
(5) x (6)	.920	1	.920	2.678	0.103	0.338	.007
(4) x (5) x (6)	.335	1	.335	.976	0.324	-0.291	.003
Error	128.776	375	.343				
Total	1108.783	386					
Corrected Total	153.428	385					

R Squared = .161 (Adjusted R Squared = .138) Lack of Fitness Test: *F*=0.852, *p*-value=0.710

V. Discussion of the Results

We observed statistically significant differences in the attitudes of the face-to-face and online students toward teamwork. Although both group of students had mainly positive attitude, the face-to-face students indicated slightly more positive attitude toward teamwork than the online students did (see Table 2). Similarly, the face-to-face students rated the relative importance of teamwork higher than the online students did. On the contrary, the online students rated their Engagement Interest and Individual Interest higher than the face-to-face students did, and the difference was statistically significant as reported in Table 2. There was no statistically significant difference between the face-to-face and online students in terms of their teamwork self-efficacy. As we previously observed in engineering students, the IT students participated in this study rated their teamwork self-efficacy very high. The class standing was the only factor with a statistically significant effect on self-efficacy. Gender was found to have no significant effect on all measured variables, excluding Engagement Interest.

The results of the *t*-test and ANOVA revealed important findings for our research questions. Both *t*-test and ANOVA indicated that the online students had higher levels of Individual Interest and Engagement Interest in teamwork despite to the fact that they had more negative attitude. Even after controlling for individual differences in the ANOVA model, being an online student was found to be a significant factor for Individual Interest (*p*-value=0.000, Eta Squared=0.049) and Engagement Interest (*p*-value=0.049, Eta Squared=0.010). This result may seem to be unexpected in the first glance. In the target student population, however, an overwhelming majority of the online participants constitute non-traditional students with full-time jobs as given in Table 1. Typically, the online students are looking forward to pursuing new careers or advancing their current careers. On the contrary, the face-to-face students are predominantly traditional students who started college right after high school. Therefore, in this study, it is safe to assume that the majority of the online students have already developed their professional skills in their current careers. This observation is particularly important for our main research question and supportive of our research hypothesis, i.e., whether interest can be used to assess teamwork skills and proficiency of students. Our findings suggest that students' individual interest is increased as they progress from a more novice stage to an expertise stage of teamwork skills and abilities. To further support this claim, 95% confidence intervals of the means of Individual Interest and Engagement Interest are plotted against Class Standing for the face-to-face and online students. Figure 1(a) shows a steeper increase in the face-to-face students' Individual Interest from the Lower Level and to Upper Level while the online students have only limited increase (both increases are not significant). This outcome is mainly due to fact that the online students have already high levels of individual interest in teamwork mainly because of their real-life work experience.



(a) Individual Interest (b) Engagement Interest

Figure 1. Growth of interest in the face-to-face and online students across their academic standing.

These findings have important ramifications for the main research objectives of this paper. First and foremost, we can use Interest as a reliable construct to assess teamwork proficiency. As predicted by MDL, learners acquire teamwork knowledge, skills, and abilities slowly, and as they become more competent in teamwork, they are willing to exert more effort in order to excel it.

In terms of the second research objective, our findings suggest that the online students tend to have more negative attitude toward teamwork compared to the face-to-face students. This finding is also parallel to some of the earlier empirical studies. The previous research mainly attributes negative attitude toward teamwork to the challenges of conducting team projects in online settings. In our case, it is clear that the online students do not lack teamwork skills; on the contrary, they have substantial professional experience. In the target program, the majority of classes include teamwork projects in order to develop students' teamwork skills. The online students may not perceive this benefit of teamwork because they have already been in many real-life team settings. Therefore, they may see online teamwork as an extra burden for their academic goals.

Clearly, better strategies and approaches are needed to incorporate teamwork into online courses, in particular for non-traditional students. One of the reasons students take online courses is that they would like to have more flexibility in their schedules. This flexibility in scheduling also leads to difficulties in arranging meetings among team members. Finding a common time, even for an online meeting, can be challenging. Another challenge of teamwork in online classes is planning overhead. The difficulty in communicating with people also contributes to the increased planning overhead for team meetings. The lack of Challenge and Explain Cycles[21] is also another disadvantage of teamwork in online learning. Face-to-face team member reach consensus by challenging one another with questions and responding to them. However, it is difficult to maintain Challenge and Explain Cycle in online team. Online team projects should be designed by considering these challenges.

VI. Conclusions

In this paper, we summarized the findings of an empirical study to investigate the differences between face-to-face and online IT students in terms of their individual and engagement interest in teamwork and the factors behind such differences. We have shown that students' individual interest in teamwork grows with their professional experience. This finding conforms to the theory of MDL which states that a learner's interest in a domain changes from situational to individual interest as the learner's expertise in the domain improves, i.e. proficient learners have a long term, personal connection to the domain, leading to its further exploration. Therefore, we recommend interest as an additional metric to measure in the assessment of students' teamwork knowledge, skills, and abilities.

VII. Acknowledgment

This work is partially supported by the National Science Foundation (NSF) under Award Number DUE-1141001. Any opinions, findings, conclusions, and/or recommendations expressed in this paper are those of the authors and do not necessarily reflect the NSF's views.

VIII. References

1. Driskell, J. E. and Salas, E. (1992) Collective behavior and team performance. Human Factors: The Journal of the Human Factors and Ergonomics Society, 34(3), 277-288.

2. Keil, M., Cule, P. E., Lyytinen, K., and Schmidt, R. C. (1998). A framework for identifying software project risks. Communications of the ACM, 41(11), 83.

3. Whittaker, B. (1999) What went wrong? Unsuccessful information technology projects. Information Management and Computer Security, 7, 23-29.

4. Perry, W. G. (1970). Forms of intellectual and ethical development. New York: Rinehart and Winston Inc.

5. King, P. M., and Kitchener, K. S. (1994). Developing Reflective Judgment: Understanding and Promoting Intellectual Growth and Critical Thinking in Adolescents and Adults. Jossey-Bass Higher and Adult Education Series and Jossey-Bass Social and Behavioral Science Series. San Francisco, CA.: Jossey-Bass

6. Alexander, P. A., Murphy, P. K., Woods, B. S., Duhon, K. E., and Parker, D. (1997). College instruction and concomitant changes in students' knowledge, interest, and strategy use: A study of domain learning. Contemporary Educational Psychology, 22(2), 125-146.

7. Vance, K., Konak, A. and Kulturel-Konak, S., Okudan Kremer, G., Esparragoza, I. "Teamwork Efficacy, Attitudes and Interest: Insights on Their Relationships," Proceedings of ASEE Mid-Atlantic Section Spring 2015 Conference, Villanova University, PA, April 10-11, 2015, 1-13.

8. Konak, A., Kulturel-Konak, S., Okudan Kremer, G.E., Esparragoza, I.E. "Teamwork Attitude, Interest, and Self-Efficacy: Their Implications for Teaching Teamwork Skills to Engineering Students," IEEE Frontiers in Education, El Paso, TX, October 21-24, 2015, 4 pages.

9. I. E. Allen and J. Seaman (2014). Grade Change: Tracking Online Education in the United States, Babson Survey Research Group and Ouahog Research Group Report.

10. Summers, J. J., Waigandt, A., and Whittaker, T. A. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. Innovative Higher Education, 29(3), 233-250.

11. Schneider, K. (2010). Ontario colleges in the digital age: Understanding the student experience, perceptions and attitudes of online learning at one Ontario College (Doctoral dissertation, University of Toronto).

12. Capdeferro, N. and Romero, M. (2012). Are online learners frustrated with collaborative learning experiences?. The International Review of Research in Open and Distributed Learning, [S.l.], v. 13, n. 2, p. 26-44, feb. 2012. ISSN 1492-3831. Available at: <http://www.irrodl.org/index.php/irrodl/article/view/1127/2129>. Date accessed: 03 Mar. 2016.

13. Grinnell, L., Sauers, A., Appunn, F., and Mack, L. (2012). Virtual teams in higher education: The light and dark side. Journal of College Teaching & Learning (Online), 9(1), 65.

14. Vance, K., Kulturel-Konak, S., Konak, A. "Teamwork Efficacy and Attitude Differences between Online and Face-to-Face Students," 2015 IEEE Integrated STEM Education Conference (ISEC), Princeton, NJ, March 7, 2015, 246-251.

15. Konak, A., Ryoo, J., and Kulturel-Konak, S. "Student Perceptions of a Hands-on Delivery Model for Asynchronous Online Courses in Information Security," Proceedings of ASEE Mid-Atlantic Section Fall 2014 Conference, Swarthmore College, Swarthmore, PA, November 14-15, 2014, 1-7.

16. Harackiewicz, J. M., Barron, K. E., Tauer, J. M., and Elliot, A. J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. Journal of Educational Psychology, 94(3), 562.

17. Alexander, P. A. (2003). The development of expertise: The journey from acclimation to proficiency. Educational Researcher, 32(8), 10-14.

18. Alexander, P. A., Jetton, T. L., and Kulikowich, J. M. (1995). Interrelationship of knowledge, interest, and recall: Assessing a model of domain learning. Journal of educational psychology, 87, 559-575.

19. Kulturel-Konak, S., Konak, A., Okudan Kremer, G., Esparragoza, I., (2015). "Professional Skills Assessment: Is a Model of Domain Learning Framework Appropriate?" *International Journal of Quality Assurance in Engineering and Technology Education*, 4(1), 33-60.

20. Hidi, S. (2006). Interest: A unique motivational variable. Educational Research Review, 1(2), 69-82.

21. Jonassen, D. H. (2004). Handbook of research on educational communications and technology. Taylor & Francis.