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PROMOTING INTERACTIVITY AND CREATIVITY IN A SCIENCE COURSE

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Abstract:

Young people entering the working force are nowadays required to compete not only on skills and education but also on creative thinking. This is because creativity and innovation are a must for businesses and nations which, today more than ever, are required to compete on the creative use of the scarce resources and the identification of new ones. Thus, promoting creative thinking among students, individually and collectively, is an educator's challenge. This paper presents the efforts made to promote creative thinking in a Human Computer Interaction course and the students' evaluation of these efforts.

Keywords: creativity, creative learning environments

I. INTRODUCTION

Innovation is tightly coupled with creativity. Creative thinking must be cultivated, and encouraged. Young people should be exposed to original ideas, new and old, and aim for enriched life experiences which they can acquire at school, at home, while traveling, when they are investigating something interesting and new, or reading about new developments, or new research output. Albeit not all ideas that will be conceived will be doable, if we collectively exercise more creative thinking, many ideas will be spawned, some will be implementable and may eventually become successful developments. There are many examples of creative ideas which account for this belief, such as, Facebook, Instagram, Airbnb, and so many more. Obviously creativity and innovation exist in all areas of practice. As Rubenstein et al., put it, "The beauty of creativity lies in its universality." [Rubenstein, McCoach, & Siegle, 2015].

II. ABOUT CREATIVITY

Creativity is defined as:

- "the intellectual ability to make creations, inventions, and discoveries that bring novel relations, entities, and/or unexpected solutions into existence" [Wang, 2013];
- "the ability to make connections between previously unconnected ideas" [Koestler, 1964];
- "imaginative activity fashioned so as to produce outcomes that are both original and of value" [National Advisory Committee on Creative and Cultural Education, 1999].

After years of investigation of creativity, [Piiro, 2000] has concluded that: creativity is domain-based; creativity and talent can be developed; and creativity is not a general aptitude, but is dependent on the demands of the domain. These are important findings as they encourage individuals to opt for creativity and educators, managers and others who can promote creativity, to do so.

The key elements of creativity as identified by [Desaily, 2015] are:

- Generating new ideas;
- Applying known skills and ideas in different contexts;
- Taking other people's ideas or starting points and moving them on or personalizing them;

- Communicating ideas in interesting or varied ways;
- Putting different or disparate ideas together to make something new;
- Working towards a goal or set of goals;
- Evaluating your own or others' work;
- Adapting and improving on work in the light of your own or others' evaluations.

Being imaginative, having insight or intuition, being open and perceptive, being willing to take risks, and having a high tolerance for ambiguity, have been identified by Jane Piirto as key personality attributes which contribute to creativity [Vinyets, 2014]. For educators it should be seen as a challenge to find creative ways to encourage and cultivate into students' minds these attributes.

REFLECTIONS ON CREATIVITY

A long list of reasons to support engaging in creative thinking can be compiled. Several of these are listed (Figure 1) by the National Youth Council of Ireland which has initiated the Creativity and Change program to promote creativity.

-
- Creativity opens the mind.
 - Creativity frees the mind in a way that enables a person to absorb knowledge more easily.
 - Creativity enables alternative ways of thinking.
 - Creativity allows recognition of uniqueness and identity.
 - Creativity can help hidden talents and inner capacities to emerge.
 - Creativity inspires collective thinking.
 - Creative participation nurtures a sense of togetherness and can nurture teamwork and cooperation.
 - Creativity challenges. Creativity instills curiosity. It encourages questions.
 - Creativity nurtures confidence. Creative expression gives a voice.
 - Creativity can support young people to be more active and present as members of society.
 - Creativity stimulates and motivates.
 - Creativity is fun and joyful and surprising.
 - Creativity engages different learning styles.
 - Creativity nurtures ideas.
-

Figure 1 Why is Creativity Important and What Does it Contribute? [Carson, 2019]

CREATIVITY AND EDUCATION; THE 21ST CENTURY STUDENT SKILLS

While the main aim of education, being to develop the young into capable members of the society, remains the same over the years, the purpose of education is being revisited every so many years. Figure 2 which follows exemplifies this point.

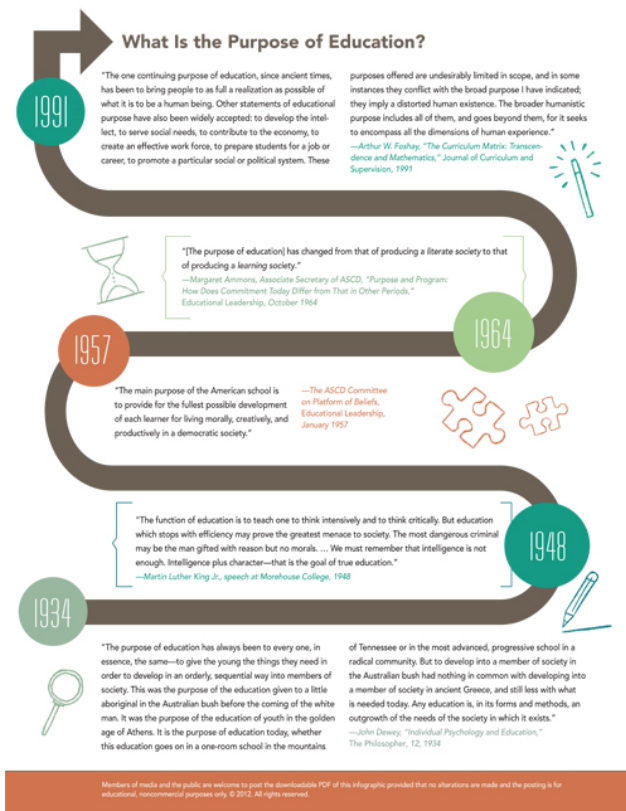
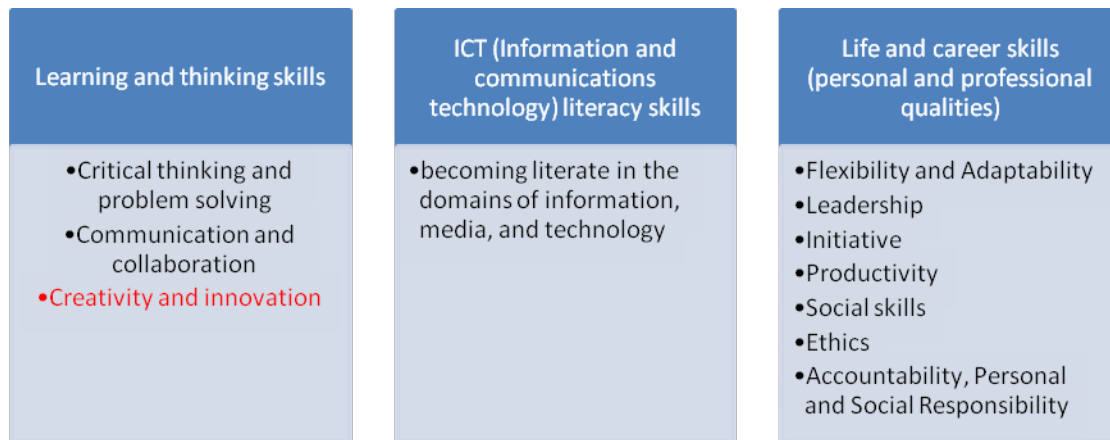


Figure 2 What is the purpose of education?
(http://www.ascd.org/ASCD/pdf/journals/ed_update/eu201207_infographic.pdf)

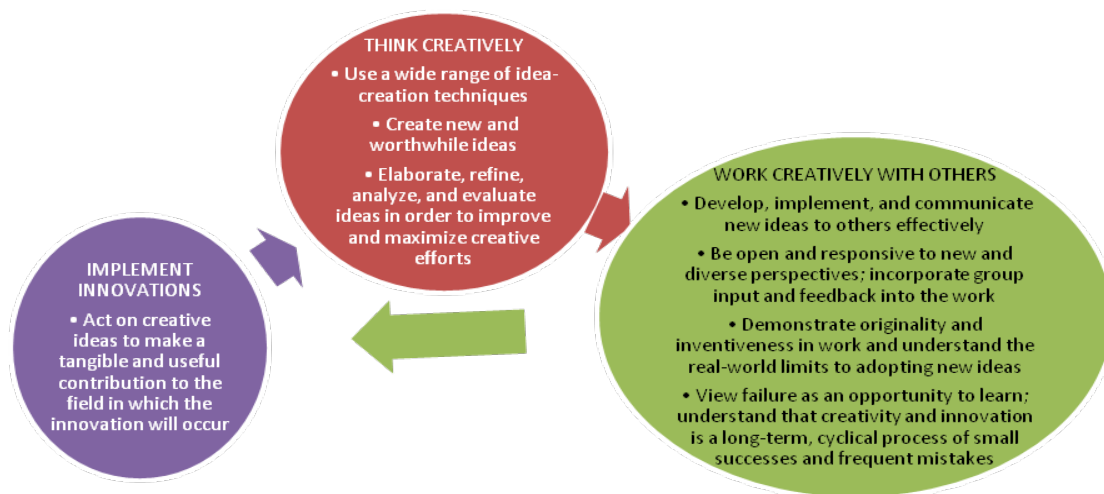
"Education should prepare young people for life, work and citizenship... Knowledge of the natural and engineered environments and how people live in the world is critical to all three purposes of education. Critical thinking, creativity, interpersonal skills and a sense of social responsibility all influence success in life, work and citizenship." Arthur H. Camins, Director of the Center for Innovation in Engineering and Science Education at the Stevens Institute of Technology in Hoboken, N.J. [Camins, 2015].

Creativity and innovation are included in the learning skills of the 21st century which were identified as the abilities and skills needed for students in order to succeed in their careers [Trilling & Fadel, 2009], [Applied Educational Systems, 2019]. Several organizations have developed frameworks for 21st century skills which refer to content and processes that the teachers should convey as part of students' schooling [Chris, 2009]. Amongst them are the Partnership for 21st Century Skills [Partnership for 21st Century Skills, 2006], the [Metiri Group & NCREL, 2003], the American Association of Colleges and Universities (AACU) [American Association of Colleges and Universities, 2007], and the Organization for Economic Cooperation and Development (OECD) [Organization for Economic Cooperation and Development, 2005]. In the Information Age of the 21st century the following abilities/skills are seen as necessary for students in order to succeed in their careers (Figure 3). These skills can be grouped in three categories as learning and thinking skills, literacy skills, and life and career skills.

Figure 3 The 21st Century Student Skills

The American Association of Colleges and Universities also gives attention to the knowledge of human cultures and the physical and natural world, and integrative learning which will facilitate the application of skills, knowledge, and responsibilities to new and complex problems and settings.

More specifically on creativity and innovation skills, [P21 Partnership for 21st Century Learning, 2019] adopts a breakdown into: Thinking creatively; Working creatively with others and Implementing innovations (Figure 4).

Figure 4 Creativity and Innovation operational content [P21 Partnership for 21st Century Learning, 2019]

CREATIVE LEARNING ENVIRONMENTS

The term “Creative Learning Environment” refers to an environment that is designed to promote ‘creative learning’ and it includes the physical as well as the pedagogic environment [Davies, et al., 2014].

Teaching creatively is not the same as teaching for creativity. Teaching creatively suggests that teachers use imaginative approaches to make learning more interesting, exciting, and effective.

Teaching for creativity on the other hand is used to describe forms of teaching that are intended to develop young people's creative thinking or behavior [National Advisory Committee on Creative and Cultural Education, 1999]. The two may happen simultaneously [Desaily, 2015] or at least teaching for creativity involves teaching creatively [National Advisory Committee on Creative and Cultural Education, 1999].

Components of teaching for creativity listed in the literature include [Davies, et al., 2014]: teacher skills and attitudes; a willingness to act as a role model; awareness of learners' needs; flexible approaches to curriculum and lesson structure; particular types of classroom interaction with pupils; the use of ICT; assessment. There is also additional evidence to support: the importance of school culture in supporting or impeding creative practice; the need to elicit teachers' prior conceptions of creativity in education; teachers taking on the role of learners to develop their own creativity; working co-constructively with a mentor or coach – which may be a creative professional from an outside agency; and the importance of teachers undertaking action research and reflection on their own classroom practice.

Qualitative aspects of learning including teaching for creativity and integrative and applied learning often receive limited attention as the pressures for fixed curriculum objectives and constraints, assessment and examination-led approaches is often the reality faced in schools [Davies T. , 2005], [Dobbins, 2009]. Educators are often presented with a challenge as to how they might incorporate creatively the teaching for creativity and the need for practice and synthesis of skills and knowledge in their courses. Thus, it is important to understand how creativity can be cultivated and encouraged.

III. APPROACH FOLLOWED; HCI COURSE RE-DESIGN

The approach we followed in this study involved redesigning a science course in order that more interactive activities intended for the development of creative thinking could be scheduled within the weekly meetings of the course. We selected an elective course so as to have a more varied student cohort and somewhat more flexibility in terms of time and content without compromising on the course objectives.

The Human Computer Interaction course is offered as a computer elective to students following the Computer Science, Computer Engineering, and Management Information Systems programs of study. Students of other programs may also take the course as a general elective. The course is being scheduled on three-hour weekly meetings during the semester. These meetings were traditionally being devoted to lecturing towards the coverage of the course content. The course included a graded project which was completed either individually or in pairs. Other graded activities included the participation of students to online discussion topics facilitated by the educator through the course forum and a comprehensive written final examination.

In re-designing the course the educator at first made a selection of the course content which would cover the primary course objectives. Additional content was separated and offered to students as added readings. This enabled the educator to adopt a more flexible approach to lesson structure. Thus, the taught component of the course was usually scheduled to take only the first half of the weekly meeting. The second half of the meeting was devoted to various activities designed to promote interactivity and creative thinking. Such activities included watching video presentations, reading news articles, studying research papers, etc. with the main aim being to expose students to recent developments in the area of HCI. Except from the videos which were presented to the whole cohort, other material was commonly split in a number of ways and distributed to students who were usually mixed up and then grouped in pairs or bigger groups. In this way the educator aimed to encourage student interactivity and promote group dynamics and potential. At other times and especially for longer videos and readings students were instructed to go through these before coming to the class. Once the groups read the assigned content a number of tasks were following. In some instances the groups only needed to highlight and present to the class what they read so that when the presentations were completed,

the class would have knowledge of the complete material. From there on a class discussion orchestrated by the educator, would follow and/or the groups would continue with other assigned tasks. These sometimes required the students to engage in brainstorming for idea generation, share past experiences, identify examples related to the topic, do some design work, and more. At all times the output of each group's workings would be presented to the whole class and more discussion would follow. The activities performed in the class would sometimes open the way to an online asynchronous discussion which would follow on the course forum.

Through the Discussion Forum, the educator intended to expose the students to new and evolving areas and research on HCI, by carefully selecting Discussion Topics (DT) which dealt with new developments, research activities, and a variety of HCI topics. Initially the topic was introduced using some video, article (research or other), lecture presentation, new product/service presentation or a combination of these. The students were not required to participate to all of the discussions and could thus select to participate to the DTs of their interest. Their participation required them to: investigate the topic further by identifying more resources related to the topic as well as relevant examples; enter the discussion by posting an initial contribution to the DT of approximately 250 words length, supported by evidence and examples, including personal experiences and properly referenced. Between those who selected to enter a certain DT a discussion should be created by responding, commenting, offering positive criticism and ideas to each others' contributions. The educator monitored the discussion taking place, and offered encouragement and motivation in order to increase participation and reward the students for their efforts and contributions.

Through the various synchronous (in-class) and asynchronous course activities the educator aimed to encourage the students to think creatively and work creatively with others. In order to also practice implementing their ideas, at least in the form of a prototype, the students had to complete a project either individually or in pairs. The project was in many ways promoting all three components of creativity and innovation skills outlined by P21 Partnership for 21st Century Learning [P21 Partnership for 21st Century Learning, 2019] being: thinking creatively, working creatively with others, and implementing innovations (Figure 4). First of all they had to think creatively and propose a specific project which according to the requirement of the educator it should simply be possible to describe as the "Happy Project". Thus, the students had to come up with an innovative application/tool/service which would enable end-users with some specific task while at the same time it would create such a positive experience which would bring about happiness to those using it and the environment. Some resources were given by the educator to help the students to come up with the project idea. Once their proposal was approved by the educator the students were instructed to follow a user-centered approach to development. Finally, with the completion of their project, at the end of the semester, the students presented their project to their fellow students and received their feedback.

For the course assessment the students were awarded points for all of the activities described above. Firstly, a given percentage of the grade was acknowledging the participation of the students in the course and it included the in-class participation and the online participation in the discussion forum. This was aiming at keeping the students alert throughout the course duration and reward them for their contributions. The second item in assessment was the course project and the last one was a comprehensive written final exam which aimed to check the students' knowledge of the theoretical content of the course.

IV. STUDENT EVALUATIONS

At some point close to the middle of the semester the educator sought the students' feedback regarding the efforts made and has asked them to informally put on a small piece of paper what they liked (+ side) and what they did not like (- side) about the course. With the feedback received the educator was able to make some adjustments to the course in order to satisfy more students. Upon completion of the course, the students were asked to evaluate the educator's efforts for promoting interactivity and creativity by completing an online questionnaire. The questionnaire collected some demographics information followed by a table with fifteen items which needed to be evaluated on a 7-point Likert scale with 1 used for Strongly Agree and 7 used

for Strongly Disagree. One last question which formed an overall evaluation of the course offering concluded the questionnaire. The students could also sign up to get the results of the evaluation when the study was completed.

PARTICIPANTS

The participants were twenty two university students who have contributed to an online survey which they took after they completed an elective course on Human Computer Interaction. From these, three students completed only the demographics. The student crowd was of mixed majors offered by the School of Sciences and Engineering and the Business School. The majority of the students were following a program of study offered at the local university; only three students were on an exchange students' program visiting from other countries. The demographics of the participants' group can be seen in the summarized charts below (Figure 5).

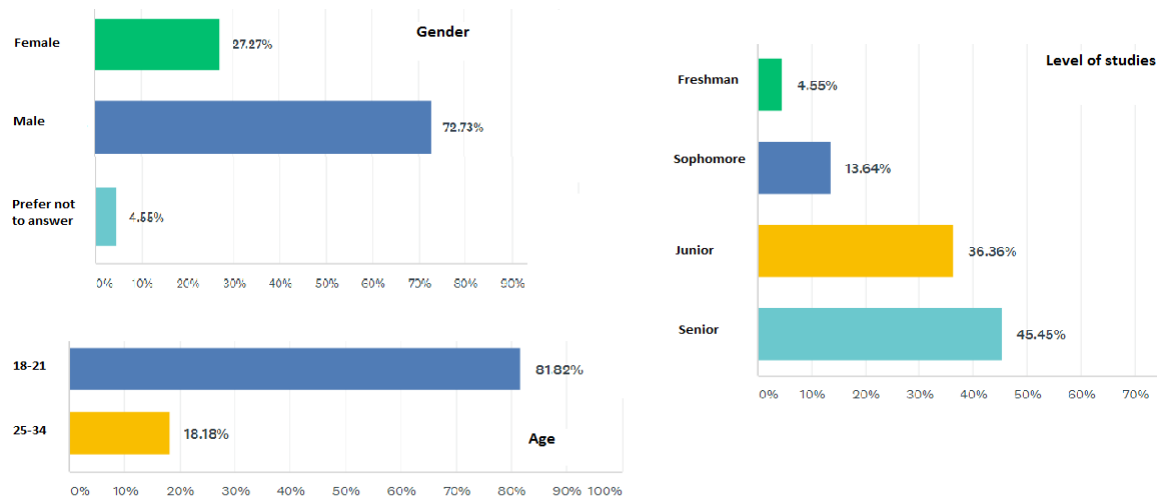


Figure 5 Demographics of participants

V. DISCUSSION OF RESULTS

The students were asked to evaluate whether the listed learning practices have offered positively in creating a creative learning environment in the class. They had to form an opinion for each of the fifteen practices which were investigated using the 7-point Likert scale. The practices are listed and coded in Table 1.

With an overall average of 85.8% the students denoted their agreement (Strongly agree, Agree, and Somewhat agree totals) with the statement that these practices have indeed contributed to the promotion of interactivity and creativity. From the remaining students a 0.7% neither agreed nor disagreed and a 13.5% basically disagreed (Somewhat disagree, Agree, and Strongly disagree totals) with the statement. The summarized figure is Figure 6.

Table 1 Learning Practices with Code Names

Learning Practices – Code Names	Code
The course page on Moodle offered all of the weekly lecture material.	A
The course page on Moodle supported in-class activities with video, recent articles, and additional material.	B
The course was administered in a way that allowed for regular in-class activities.	C
The course involved a variety of in-class activities such as presentation and discussion of recent research in the course area, debates, brainstorming, design activities, evaluation activities, and identification of examples/personal experiences/common practices/best practices.	D
In-class activities often involved group work and required peer cooperation.	E
In-class activities fostered active engagement and participation of students in class discussions.	F
The course followed/presented recent developments in the area of study.	G
On-line discussions facilitated through the course forum involved a variety of course-related topics.	H
The course’s activities promoted student participation, interactions between students and between the students and the lecturer.	I
The communication and feedback offered was bi-directional and involved lecturer-to-student, student-to-lecturer, and student-to-student exchanges.	J
The course project encouraged group work.	K
The course project encouraged creative thinking from the conception of the project idea, to the completion of the project activities, and the presentation of the final design to the class consortium.	L
In-class and other course activities promoted creative thinking.	M
All participatory activities are considered for the assessment of the student in the course.	N
The course content and activities were delivered with great enthusiasm.	O

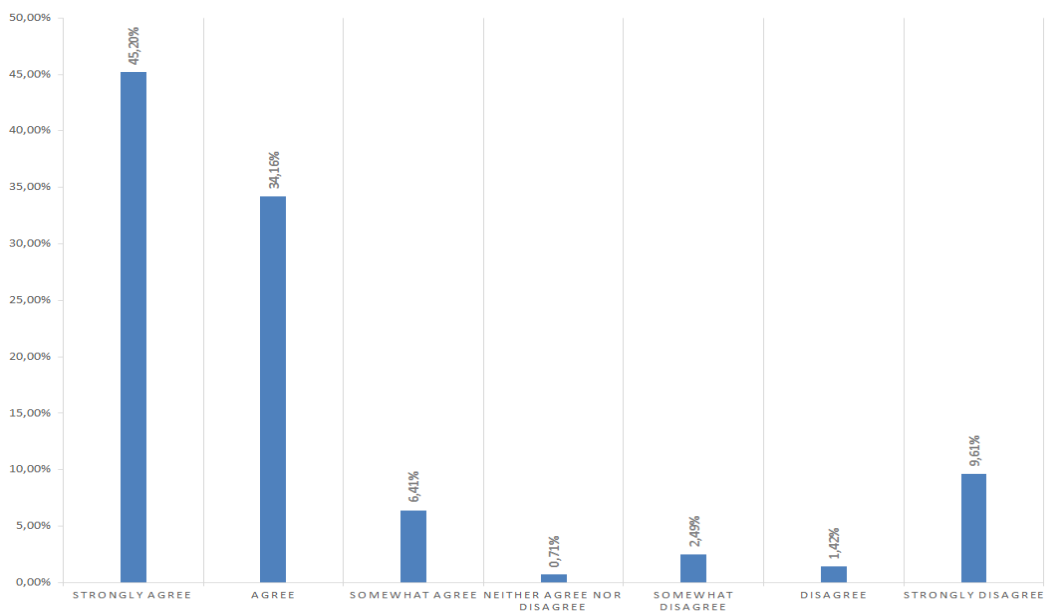


Figure 6 Student Replies - Summarized

The top two practices which were recognized by more than 50% (Strongly agree) of the student group were activities A and B which described the contents of the course page on Moodle. This was found to be complete in terms of the lecture material and supportive of the in-class activities as it offered videos, recent articles, and additional material.

The three positive answers on the scale, Strongly agree, Agree, and Somewhat agree, had their highest total for activities B, D, and J with 89.5% which involved the Moodle page support (B); the variety of in-class activities which included the presentation and discussion of recent research in

the course area, debates, brainstorming, design activities, evaluation activities, identification of examples/personal experiences/common practices/best practices (D); and the nature of the communication and feedback in the course which was bi-directional and involved lecturer-to-student, student-to-lecturer, and student-to-student exchanges (J).

It is also worth noting that the highest level of Strongly Disagree was only an 11.1%. The activity which seems to have been disputed the most is K - The course project encouraged group work - with 21.1% disagreement. Overall, no activity was judged as not offering positively to interactivity and creativity in the class as for all of the activities the majority judged them as positive offerings to the creation of a creative learning environment. Figures 7 and 8 can be reviewed for detailed results.

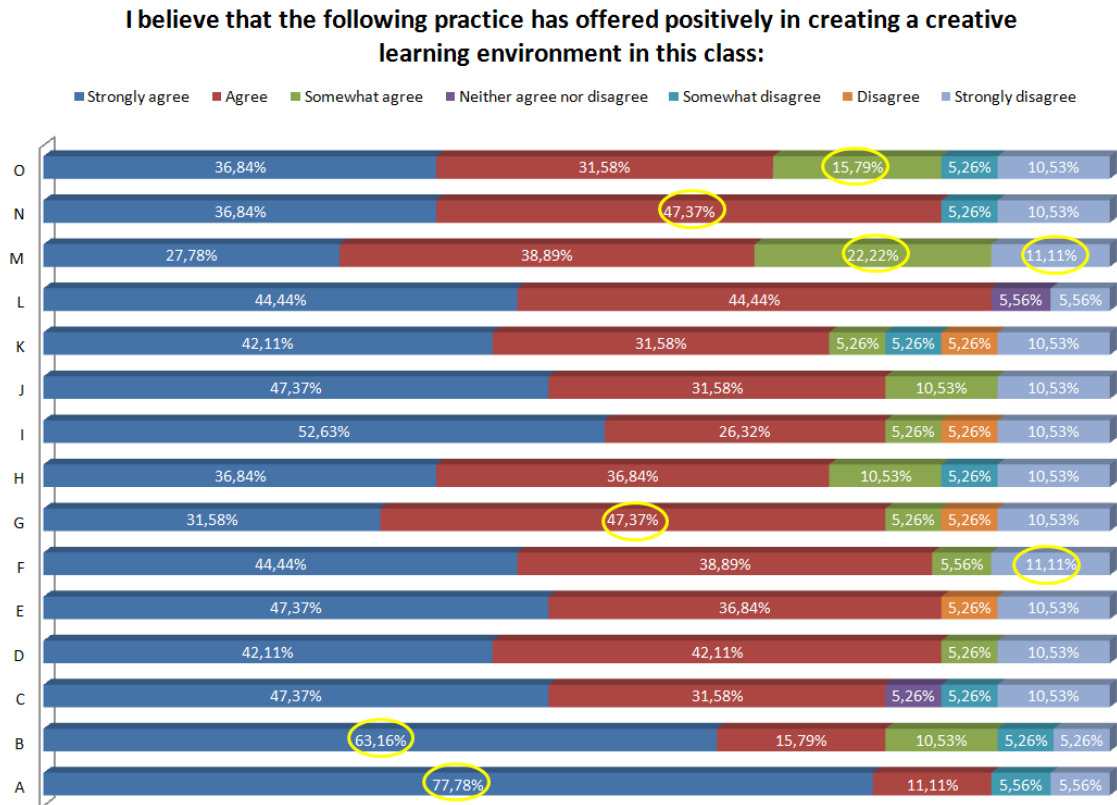


Figure 7 Learning Practices and Student Evaluation

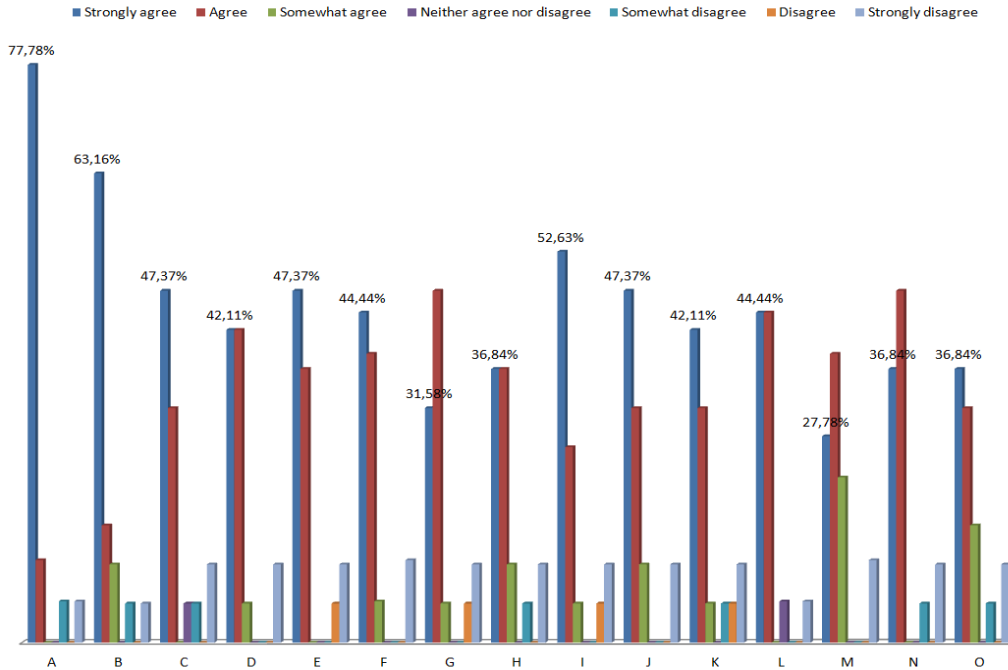


Figure 8 Learning Practices and Evaluation (2)

Table 2 below presents summary statistics. The values of the sample mean, median and mode are close to each other and fall within the 95% confidence interval for the mean.

Table 2 Summary Statistics

Sample Mean	SD	ST. Err.	Lower	Upper	Median	Mode
2.24	1.83	0.69	0.88	3.60	2	1

The last question was asking for the students' overall evaluation. The students were asked to respond to this statement: "The course culture was such that it increased the level of student motivation, engagement, enthusiasm, enjoyment, concentration, attention and focus, and enabled creativity initiatives." (Figure 9) They all agreed with this statement!

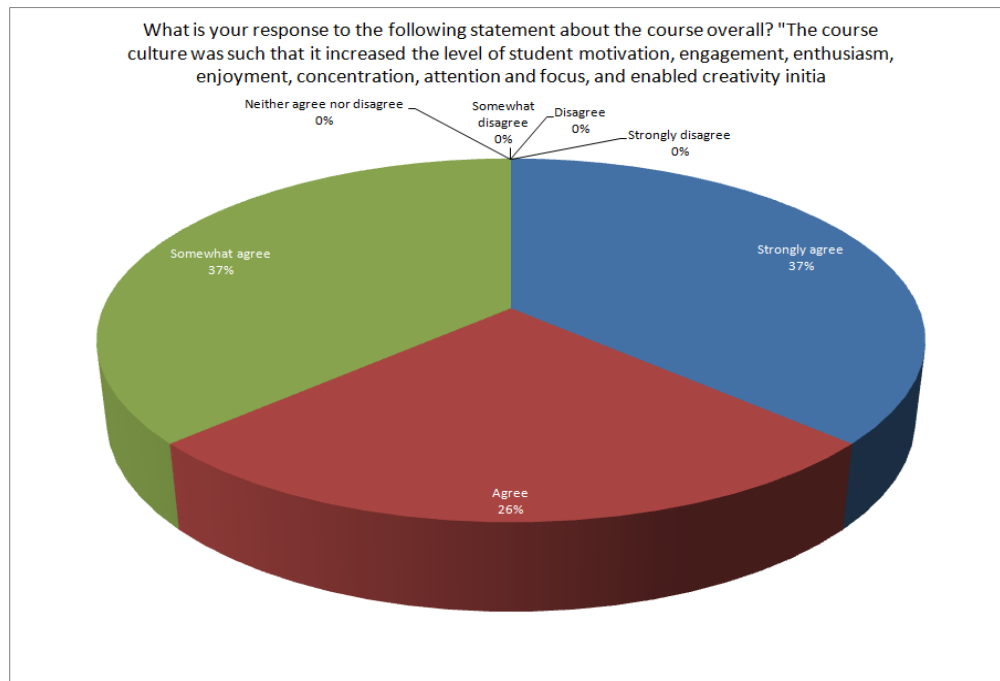


Figure 9 Student Overall Course Evaluation

VI. CONCLUSION

This paper presented the efforts made by an educator to promote interactivity and creative thinking in a Human Computer Interaction course and the students' evaluation of these efforts. In conclusion, the overwhelming positive evaluation of the students who stated that "the course culture was such that it increased the level of student motivation, engagement, enthusiasm, enjoyment, concentration, attention and focus, and enabled creativity initiatives", empowers the educator to continue her efforts towards creating an enriched creative learning environment.

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