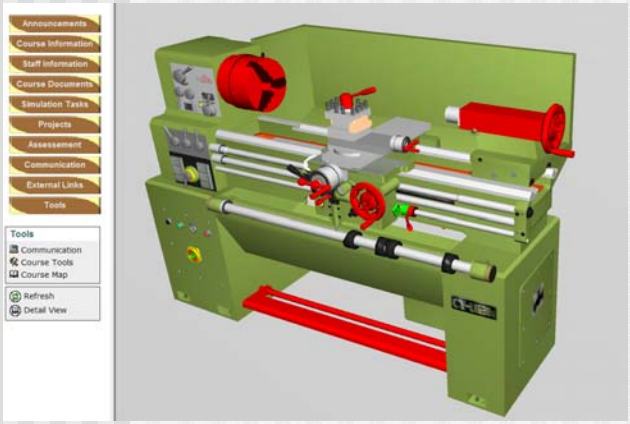

The Effectiveness of Simulation-based Learning for Polytechnic Level Engineering Students

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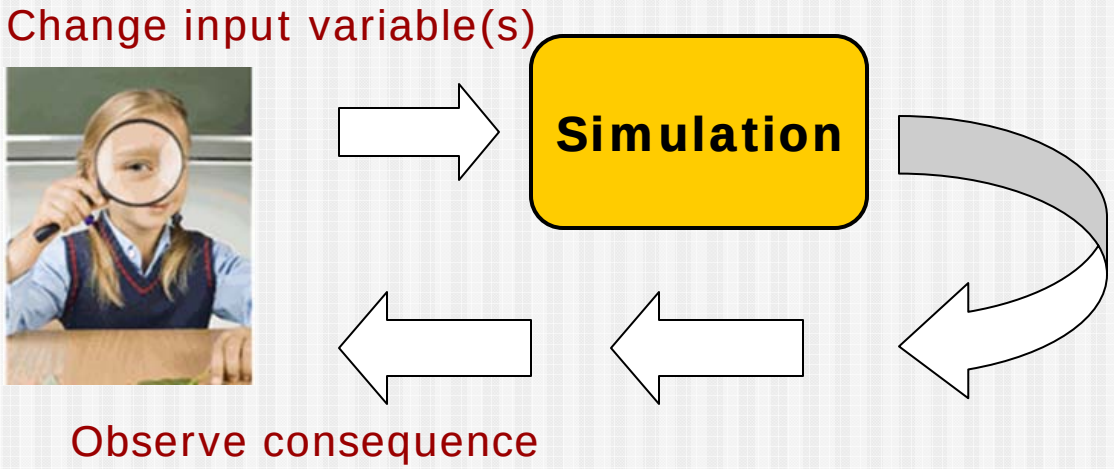
Outline

- Background
- Aim of Study
- Demonstration
- Methodology
- Findings
- Concluding Discussion

Background:
What is SBL anyway?

- Simulation: Closely resembles the physical system while allowing learners to explore, rehearse and to assess themselves.



- Learning by Doing

Background:
What is SBL anyway?

- Academic Settings:
  - Enhance lectures, laboratories
  - Engage students
- Workplace:
  - Cost-effective training
- Could it be used for post secondary engineering education at the Poly level - how effective is it?
- Machining Technology, a year 2 subject was chosen as the study subject as it satisfies most criteria for implementation

Aim of Study

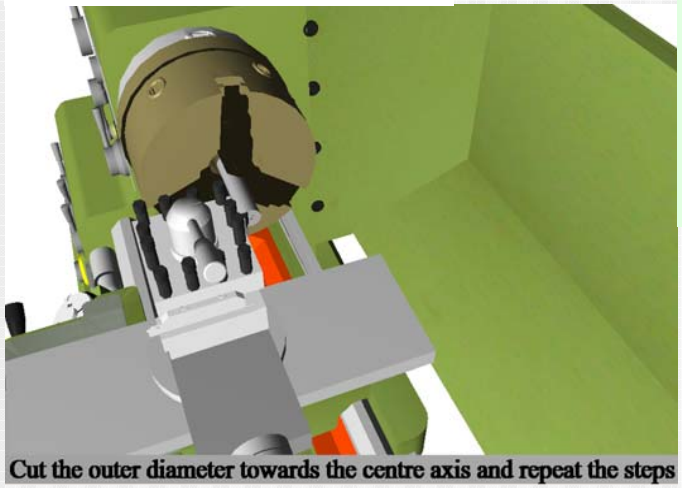
Research Questions

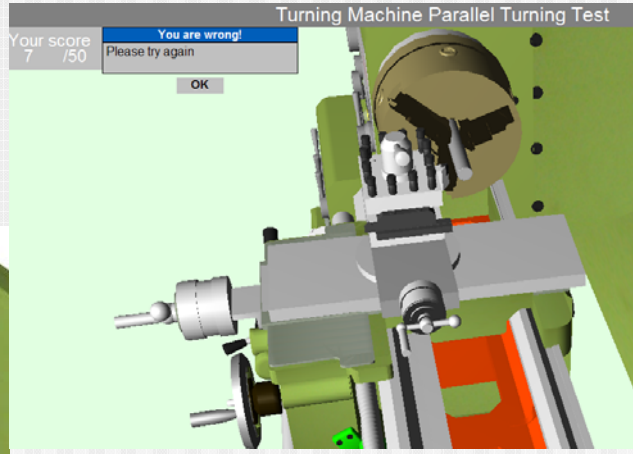
- Could SBL help improve students' learning processes when compared to traditional classroom methods?
- By accessing information in a variety of media formats/interactive fashion, could students make useful associations?
- Were students motivated by the experience?
- Which aspect of SBL assisted student learning?

Technical Devpt & Demo

Explore Machine

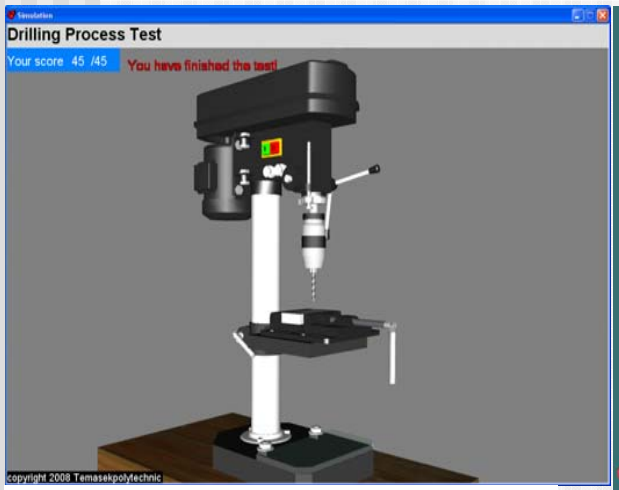
Work on the Machine Parting Off, Facing, Centre Drilling, Parallel Turning, Deep Drilling



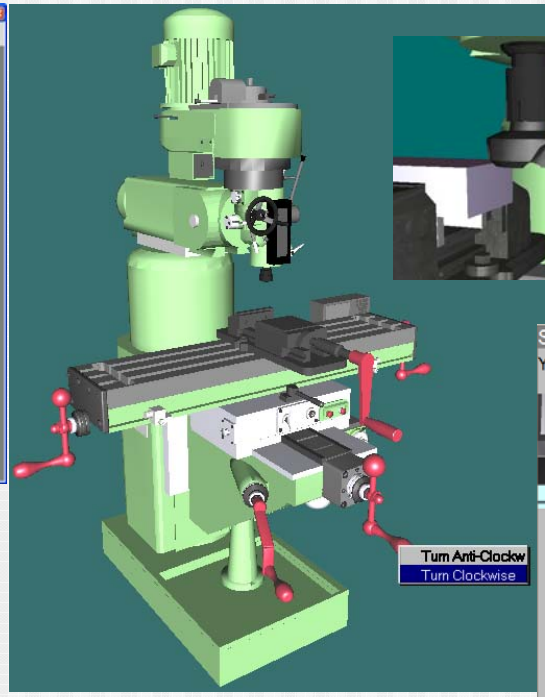


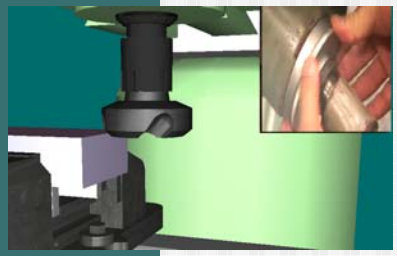
Assessment (Test)

Technical Devpt & Demo

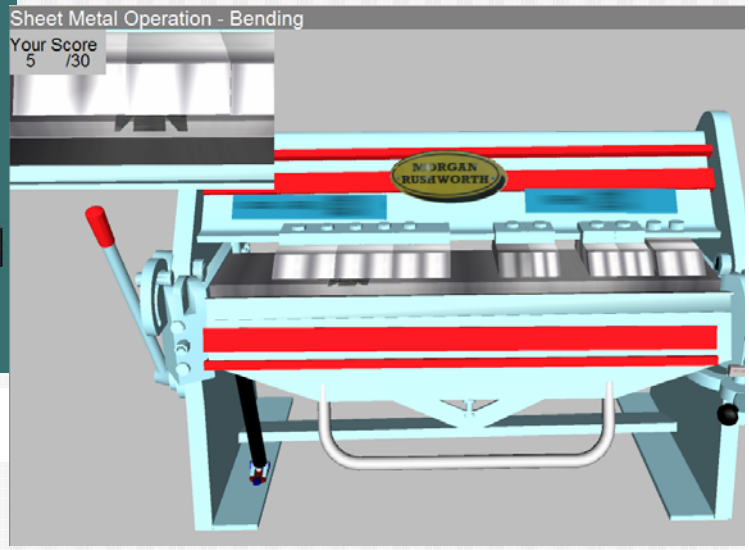


Drilling

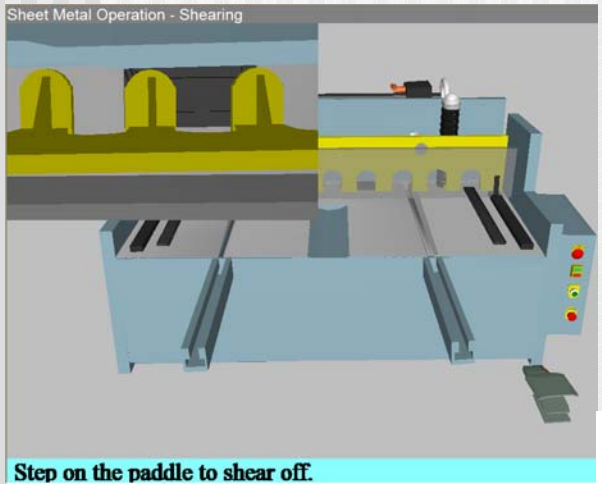




Vertical Milling



Bending Machine



Shearing Machine

Methodology

Subject matter in the study

- Machining Technology
- Complex, common subject
- Students learn fundamentals of machining, including features, functionality, operations & process
- Course instructors observe students have difficulties using machines, students may be intimidated by the complexity, size and complex procedures
- Needs visualisation, manipulation of objects, system variables, planning, understanding of machine system

Methodology

Participants

- 2nd year mechatronics students (age between 17-37, mean age = 21.12)
- 121 students took part (49 in control, 72 in expt)
- Equal variances t test for means of two groups
- No statistically reliable difference in 1st year examination results between the mean CGPA of the E and C group
- Suggests similar initial course knowledge level before they embark on the study

Methodology

Instruments

- Post Intervention Test (Performance)
  - Synthesizing Knowledge on machining operations
  - Produce a part requiring machining operations from different machines
- Survey Questionnaire (Learning/Motivation)
  - Framework based on Self-Determination Theory (SDT)
  - Scoring based on 47 Likert based items
  - 5 point scale ranging from 5 (SA) to 1 (SD)

Methodology

Instruments

Subscales	Items	Adapted from:
Self efficacy	6	Learning
Perceived autonomy	5	Psychological Needs
Perceived competence	5	Psychological Needs
Relatedness	3	Psychological Needs
Intrinsic motivation	5	Motivation
Self regulation	4	Learning
Cognitive strategy use	8	Learning
Extrinsic motivation :		Motivation
- External Regulation	2	
- Introjected Regulation	2	
- Identified Regulation	4	
- Amotivation	3	

Methodology

Intervention Procedure

- Both groups have same number of hours (4 hrs per week)
- C Group (2 hr lecture, 2 hr workshop)
- E Group (1.5 hr lecture, .5 hr lab, 2 hr workshop)

Methodology

Intervention Procedure

Teaching Schedule of Machining Technology (EME2007_ Oct0809) at MCAD Lab EN20-2-93 Rev 1.0

Week Mon - Fri	Session (4 hrs) 1st & 2nd hrs / 3rd & 4th hrs	Assessment
1 20 Oct – 24 Oct 08	**Week 1** Brief Students Workshop Visit TSO: Prepare Demo	
2 27 Oct – 31 Oct *Deepavali (Mon)*		
3 3 Nov – 7 Nov		
4 10 Nov – 14 Nov		
5 17 Nov – 21 Nov		
6 24 Nov – 28 Nov		
7 1 Dec – 5 Dec	**Week 7** Survey & Post Intervention Test	
8 8 Dec – 12 Dec		
9 15 Dec – 19 Dec	(Makeup for Project 1 workshop sessions: 15 Dec 2008 starting at 9.00 am.)** Term Break	
10 22 Dec – 26 Dec	Term Break	

Week 0

- Groupings
- Preparation
- Compare participants CGPA
- Load Models

- Both groups have 4 hrs/week
- C Group (2 hr lecture, 2 hr workshop)
- E Group (1.5 hr lecture, .5 hr lab, 2 hr workshop)

Interviews

Research Findings

Post Intervention Test

- 121 students took part in the Test (91 M, 30 F)
  - 49 Control:36 M, 13 F
  - 72 Expt: 55M, 17F
- Equal variances t-test
- Statistically reliable difference between the mean score of the E Grp and mean score of the C Grp
- Effect Size d = 0.46
- Intervention has a medium effect

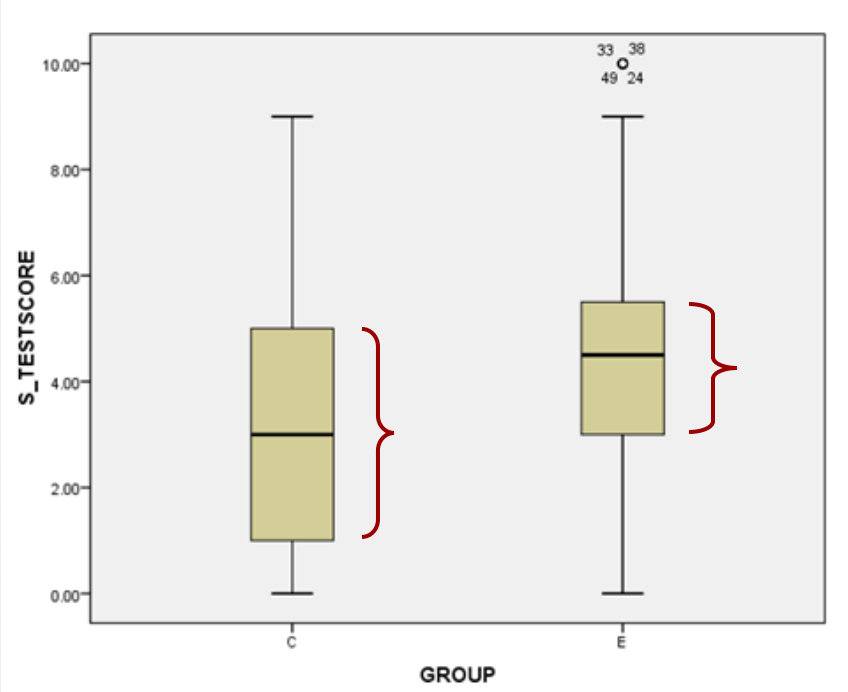
	M ($\bar{x}$)	SD (σ)	t-test * (df = 119, p < 0.05)
Group C (n=49)	3.42	2.51	*t = 2.48* *p= .015* *d=.46* Significant
Group E (n=72)	4.60	2.60	
*assumption on equal variances tested			

E: Experimental Group, C: Control Group
M: mean, s = standard deviation

Research Findings

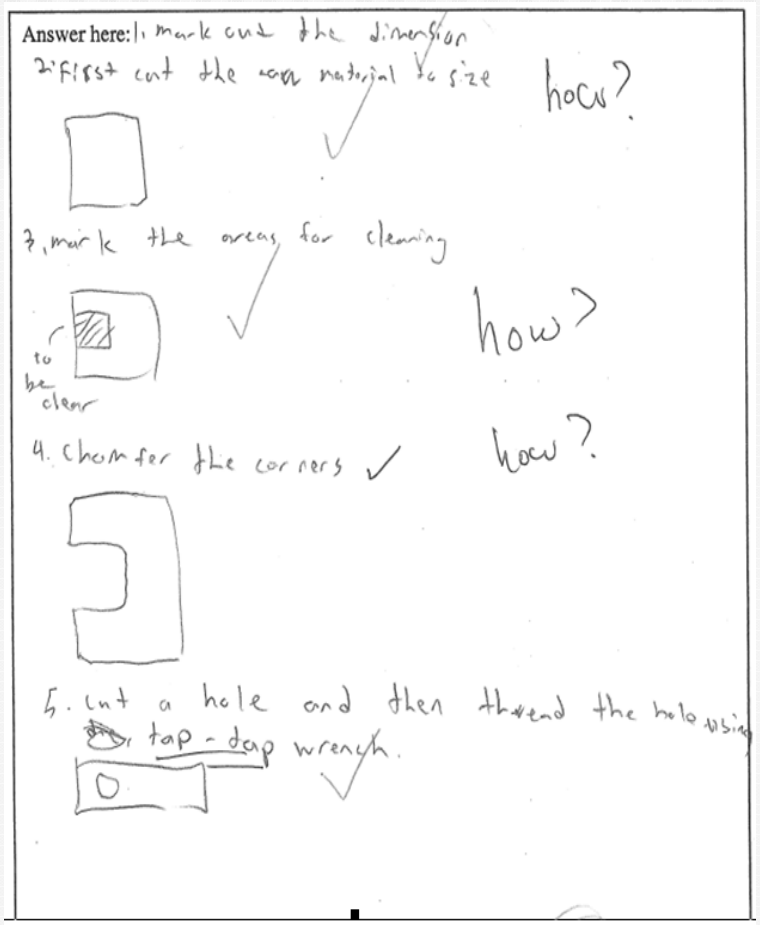
Post Intervention Test

- Box-Plot
  - Inter-quartile range (middle 50% of scores) is narrower for E Group
  - 4.00 vs 2.75
  - Less variation in understanding of subject

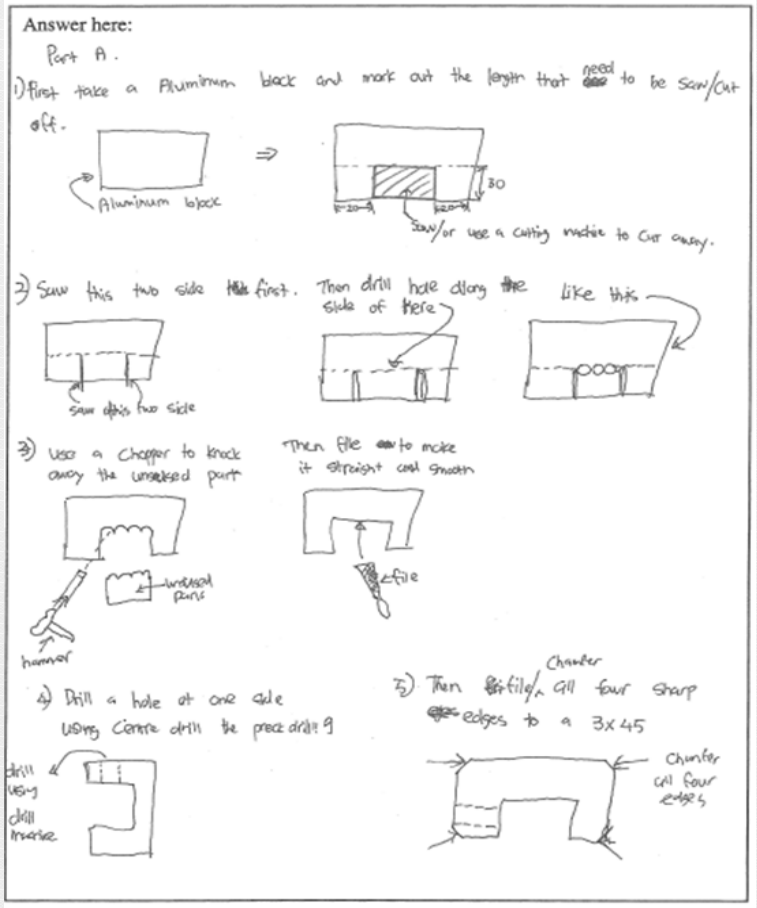


Research Findings

Post Intervention Test



Sample from C Group



Sample from E Group

Research Findings

Survey Results (Descriptives)

- Total of 114 respondents
- 45 from C Group
- 69 from E Group

	Subscale	C Group		E Group		
		M_C	SD_C	M_E	SD_E	Alpha
Learning	Self Efficacy	3.67	0.55	3.78	0.57	0.76
	Self Regulation	3.26	0.64	3.42	0.71	0.75
	Cognitive Strategy Use	3.67	0.44	3.62	0.61	0.79
Psychological Needs	Perceived Autonomy	3.85	0.46	3.58	0.65	0.76
	Perceived Competence	3.74	0.72	3.82	0.64	0.86
	Relatedness	3.50	0.81	3.58	0.71	0.78
Motivation	Intrinsic Motivation	3.88	0.80	3.73	0.69	0.83
	External Regulation	2.71	0.90	2.54	0.99	0.60
	Introjected Regulation	2.21	0.84	2.40	0.91	0.73
	Identified Regulation	4.04	0.58	4.03	0.61	0.73
	Amotivation	2.33	0.85	2.22	0.82	0.75

Research Findings

Survey Results (Descriptives)

- Total of 114 respondents
  - 45 from C Group
  - 69 from E Group
- Except for perceived autonomy, rest of subscale not significant
- However, we could draw some conclusions from looking at the mean value of each subscale

Research Findings

Survey Results (Descriptives)

- Learning (Self Efficacy, Self Regulation, Cognitive Strategy Use)

- E group students perceived that they have better self efficacy & self regulation but not cognitive strategy
  - SBL helped introduce self regulation behavior through strategies embedded into the modules, such as reflection, rehearsal, assessment, “safe” environment
  - Infusion of cognitive strategy (but students are not aware of this)

- Analysis of individual items shows perception that SBL:
  - Helped in connecting concepts and reinforce rehearsals but,
  - Harder to learn from as they have to work doubly hard to mine information and hence,
  - Could have lead to lowering of confidence

Research Findings

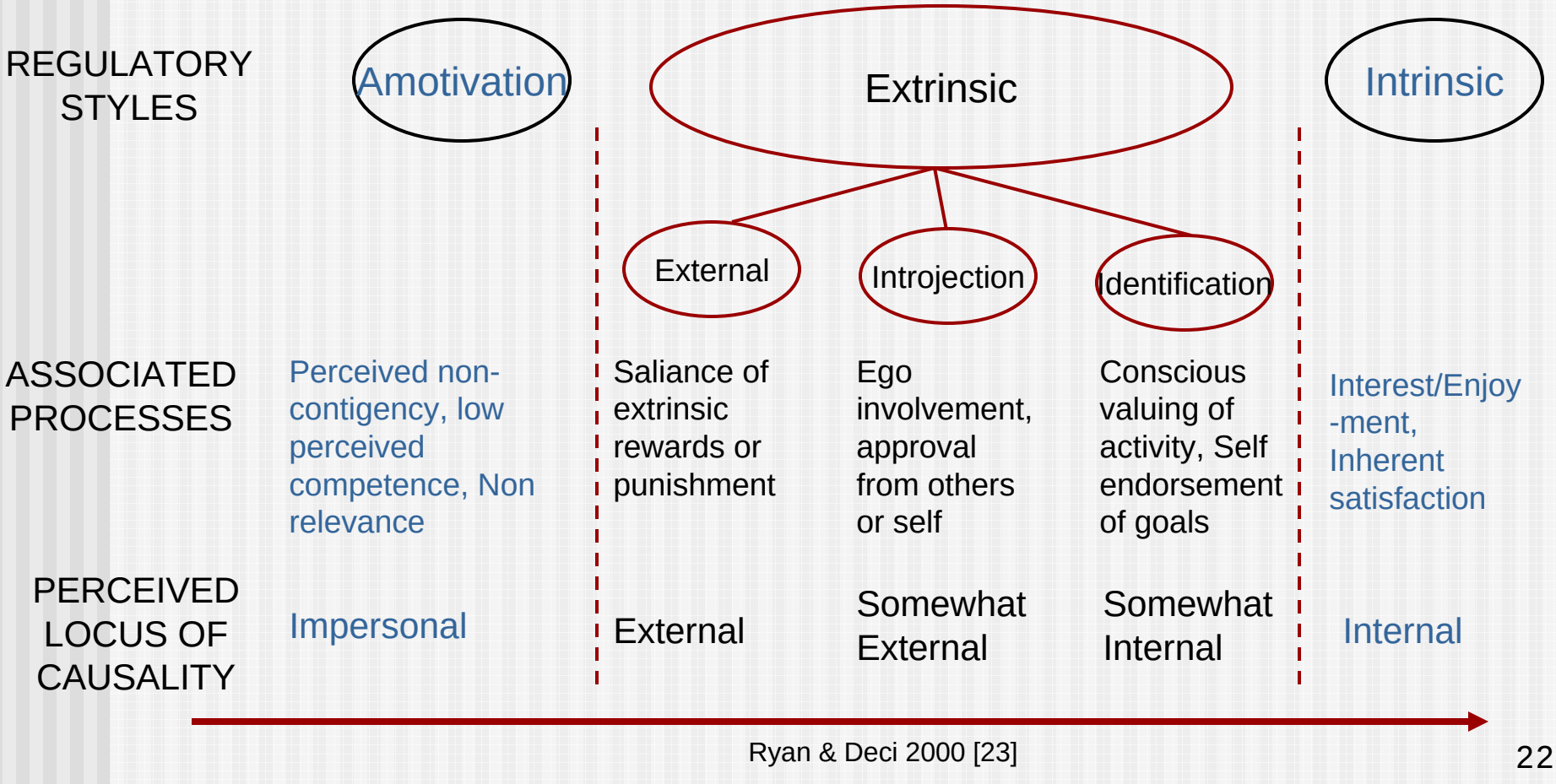
Survey Results (Descriptives)

- Psychological Needs
  - Perceived Autonomy
  - Perceived Competence
  - Relatedness
- E group students perceived that they have higher level of competence and relatedness but less autonomy
  - Students perceived that a number of their suggestions were discounted by instructors (Instructor's view was that students should not deviate from safety procedures)

Research Findings

Survey Results (Descriptives)

- Motivation



Ryan & Deci 2000 [23]

Research Findings
Survey Results (Descriptives)

- Motivation
  - Comparing means, E Group has higher introjected regulation score
    - due to internal pressure – gain some imagined approval
    - Consistent with replies where they perceive tension during learning
  - Both groups have high identified regulation and intrinsic motivation scores
    - Good learning environment is present for both groups leading to needs satisfaction

Research Findings

Survey Results (Correlation E Group)

- Learning
  - Self regulation and self efficacy positively correlated to cognitive strategy use
- Psychological needs
  - Autonomy support, competence and relatedness are significantly correlated
- Motivation
  - Positive correlation between introjected regulation & relatedness

Research Findings

Survey Results (Correlation E Group)

- Learning orientations (metacognition & self regulation) were strongly associated with 3 psychological needs (Competence, Autonomy Support, Relatedness) as well as identified regulation & intrinsic motivation
  - Weak autonomy support should be improved
- High correlates between self-efficacy and competence
  - Competence is a pre-requisite for belief in ability to carry out task to completion

Research Findings

Survey Results (Correlation E Group)

- More Autonomous forms of motivation, (intrinsic motivation, identified regulation) showed strong positive correlations with 3 psychological needs
  - Re-affirms SDT research
- Amotivation correlated negatively with 3 psychological needs, strongest with perceived competence
  - Perceived lack of competence lead to no motivation

Concluding Discussion

- Could SBL help improve students' learning process when compared to traditional classroom methods?
  - Performance has improved
  - Students seems better able to remember details
  - Learning environment to improve on autonomy support
  - Competence is pre-requisite in self belief to learn subject successfully

Concluding Discussion

- By Accessing information in a variety of media formats/interactive fashion, could students make useful associations?
  - Students found SBL to be more difficult to learn from as they have to mine for information in their many forms.
  - Students are not aware that they were using cognitive strategies in their learning
  - Could introduction of learning strategies prior to SBL help?
  - A qualitative analysis currently being carried out will reveal more insight (issues of cognitive overload, etc.)

Concluding Discussion

- Were students motivated by the experience?
  - Learning environment in current study contributed to high needs satisfaction in both groups (both groups exhibit high intrinsic and identified regulation motivation)
  - Students in E Group perceived higher competence but lower autonomy
  - E Group students has higher introjected regulation compared to C Group

Concluding Discussion

- Which aspect of SBL assisted student learning?
  - "Safe" space
  - Rehearsal
  - Prior engagement before actual workshop practice
  - Self Assessment
- Qualitative Analysis will reveal more information

Q & A