EXPLORING THE INFLUENCE OF GROUP CHARACTERISTICS ON INTERACTIONS DURING COLLABORATIVE GAMING

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ABSTRACT

Collaborative gaming is evolving into the latest pedagogically stimulating scenario motivating research from different perspectives. Group-based gaming is analysed through a methodology that integrates the role of various variables in mediating interactions. An interactions-oriented pedagogical model categorises task and person-oriented interactions (T&POIs) along the domain, technology and community dimensions, and across three pedagogical levels. Using this model, P&TOIs, directionality of interactions, individual gaming roles adopted during collaborative gaming and level of friendship shown by participants are quantified in relation to group characteristics - group composition by gender, by gaming competence and by level of friendship, group size and emerging collective gaming strategy. The different interactions profiles are compared and contrasted to identify factors and processes that influence interactions. Factors that determine effective collaborative gaming will be identified to guide pedagogy for collaborative game-based learning.

KEYWORDS

Collaborative gaming, Gamed-based learning, Interactivity, Collaboration, Pedagogy, Process-oriented approaches.

1. INTRODUCTION

Digital games are evolving beyond the solitary context into a ubiquitous collaborative experience. LAN gaming parties, Massive Multiplayer On-line Games (MMOGs) and contiguous collaborative gaming contexts are providing social environments serving both as a focal point for technology-mediated social interaction and as an environment for experimenting with one's projected identities. Acknowledging their crucial role in promoting acquisition, participatory and contributory forma of learning, some forward looking educational and training institutions are reacting to this new reality by supporting the development of serious, educational games and attempt to integrate them in learning and work.

But integrating such stimulating experiences with instruction poses major challenges to educators, demanding a paradigm shift in conceptualising the learning process. The seminal works of Salomon (1990; 1996) and Dillenbourg, *et al* (1996) on collaborative learning emphasise the need for research to move from a focus on independent variables and establishment of parameters for effective collaboration, to concentrating more on trying to understand the role that such variables play in mediating interaction. Kreijns *et al*, (2003) identifies Task and Person-oriented interactions as fundamental components in technology-intensive collaborative learning environments. Consequently a model inspired by this research and Constructionist epistemology is being proposed for organising interactions in collaborative gaming contexts.

2. THEORETICAL FRAMEWORK

During collaborative gaming, individual, group and task features determine T&POIs that occur along the Domain, Technology and Community dimensions, and progress across three pedagogical levels – the basic 'Acquisition' level, through 'Participation' to 'Contribution' modes of learning. Game genre determines interactions along the domain dimension through which knowledge and skills are acquired. Interactions with the game itself and gaming device, develops competence in the use of digital tools and gaming tactics. The community dimension captures the socio-emotional climate and interpersonal interactions manifesting underlying relationships and roles. Considering the importance of individual and social metacognition as discussed in detail in Bonanno (2004), a meta-component for managing interactions along the identified dimensions was also included in the model. A more detailed discussion of this model may be found in Bonanno (2005), where it is applied to identify learning profiles of participants in Web-based communities.

Along the community dimension interactions with other participants are determined by three socially-oriented needs. Through a process of intra-personal analysis and interpersonal comparison participants acquire both task and community-related competence. Once such need is fulfilled, personal resources will be channelled to address the need for relatedness, affiliation and possibly intimacy through the psycho-social processes of mentalising, social monitoring and interpersonal communication. The intensity of interpersonal relationships in collaborative contexts is determined by the personal attributes of participants, the particular task at hand and by group characteristics. For example different T&POIs will evolve within a group of competent gamers as compared to those in a novice one. TOIs include giving help, sharing, providing feedback, recommending or censuring game. POIs, that shape the socio-emotional climate characterizing a group, include communication through different facial expressions such as pleased, neutral or disagreeing looks, jubilant expressions, approving or disapproving gestures, expressions of task rejection, body language showing disengagement and possibly hostile behaviours. Globally these interactions describe the level of 'well-being' arising from needs satisfaction by the collaborative gaming experience.

To quantify these interactions collaborative gaming sessions were recorded on video controlling for group-related variables. These were then analysed to identify underlying factors that have to be controlled for efficient and effective use of games in collaborative contexts.

3. EXPERIMENTAL VALIDATION

The main research question of this investigation is: '*How do Group characteristics, mainly group composition by gender, by gaming competence and by level of friendship, group size and emerging collective gaming strategy, influence the frequency and directionality of T & POIs during collaborative gaming*? A number of empirical research questions (ERQs) were developed around key group-related constructs determining the different treatment conditions that are discussed in the following section.

3.1 Defining constructs under investigation

This investigation focused on a number of constructs related to group composition and size.

3.1.1 Group Composition by Gender

How do male, female and mixed gender groups influence interactions during collaborative gaming?

Analysing video recordings of experimental sessions revealed that task-related strategies and socio-emotional climates contrasted a lot between male, female and mixed gender groups. This was immediately considered as an expression of underlying sexually differentiated social skills (Geary, 1998) involving sexual division of labour, coalition-based competition and gender-based neuro-cognitive and affective propensities. These gender-related differentiated behavioural patterns were investigated by quantifying the frequency and directionality of T&POIs. Being more task-oriented boys prefer competitive, gregarious social contexts. Females tend to be more person-oriented being more inclined to secluded, friendly contexts. Males consider ICT applications and games, as more useful learning tools, Bonanno & Kommers (2007) since these accommodate to their manipulation-oriented information processing approach (Halpern & Wright, 1996;

Casey, 1996). Thus they prefer a 'command' strategy, greater risk taking when executing tasks, and a competitive social comportment when using ICT, Turkle & Papert (1990), Singh (2001) and Rommes (2002).

The direction of interactions during collaborative gaming was also investigated employing ideas from Social networks theory (Freeman, 2004). Frequencies of the following directionality variables were recorded: 'one-to-one', 'one-to-all', 'total number of interactions', leader to executor, leader to participant, executor to leader, executor to participant, participant to leader, participant to executor, participant to participant. A leader is the participant who manages group activity, while an executor is the person using the keyboard and mouse to control the game. T&POIs and directionality of interactions for single and mixed gender groups were compared to establish possible influence of composition by gender on interactions. (ERQI below).

3.1.2 Group composition by Collective gaming competence

Perceived competence determines power relationships (Piaget, 1965) and thus roles in groups. Group members that perceive themselves as more competent tend to adopt leading roles, while participants perceiving themselves as less competent tend to be more passive. Research has attempted to determine the optimal degree of differences - if too small, it may fail to trigger interactions; if too large, interactions are inhibited. Vygotsky's concept of 'zone of proximal development' defines the optimal difference, not as a difference between subjects A and B, but as a difference between how A performs alone and how A performs with B's assistance. The optimal combination of participants with different gaming competence (enthusiastic, moderate and non-gaming) in collaborative gaming contexts has to be established.

The gap in gaming competence may prove to be a strong determinant of the type, frequency and directionality of interactions. It is expected that the effect of gaps in gaming competence within experimental groups will lead to variations in interaction profiles and socio-emotional climates characterised by different frequencies and directionality of interactions and group roles. (ERQII)

3.1.3 Group composition by Level of Friendship

Friendship heterogeneity determines the socio-emotional climate in groups which in turn influences directly interactions in collaborative gaming contexts. Rourke (2000) remarks that students will engage wilfully in collaboration and recognize the collaboration as a valuable experience only if they trust each other, feel a sense of warmth and belonging, and feel close to each. Wegerif (1998) noted that ''forming a sense of community, where people feel they will be treated sympathetically by their fellows, seems to be a necessary first step for collaborative learning. Without a feeling of community, people are on their own, likely to be anxious, defensive and unwilling to take the risks involved in learning'' (p. 48). These psycho-social processes are not directly related to the task in the strict sense but essential in creating a climate for efficiently interacting teams. The process involves initial reciprocal acquaintance, the development of a group's history, and opportunities for social interaction to develop friendship and camaraderie. It is thus hypothesised that friendly groups develop a more positive socio-emotional atmosphere involving higher degrees of interpersonal communication, enhanced joint problem solving and collaboration. Groups with different composition regarding friendliness (friendly, partly and non-friendly) will show different socio-emotional atmospheres characterised by varying type, frequency and directionality of interactions. (ERQIII)

3.1.4 Collective gaming strategy

Analysis of video recorded collaborative gaming sessions revealed that groups use different tactics to deal with gaps in friendship or gaming competence. It was thus decided to classify experimental groups according to three emerging role profiles: 'Guided' groups having a member acting as a leader; 'Collaborative' groups where leader role is distributed among group members; and 'Exploratory' groups with no established leader/s where members adopted an 'ad hoc' unorganised approach to gaming, with little effort at co-ordinating group activity. It is assumed that the frequencies for different categories of T&POIs, directionality of interactions and communication activity vary according to the gaming strategy adopted by a group. (ERQ IV)

3.1.5 Group size

Empirical studies about ideal group size for fostering interactions showed that in non-gaming task-oriented classroom situations pairs are more effective than larger groups. Groups of three are less effective because they tend to be competitive, whilst pairs tend to be more cooperative (Trowbridge, 1987). However,

differences between group sizes seem to disappear when students are given the opportunity to interact freely with others in class (Colbourn & Light, 1987).

To explore the effect of group size on interactions in collaborative gaming, experimental groups with different numbers of participants (3/4/5/6-members) were set up. The pair condition was eliminated to include two participants with a game executor. The effect of gender and gaming competence on interactions was controlled by including male, female, mixed gender, enthusiastic, moderate and non-gaming groups with different number of participants. The interaction of group size under different experimental combinations with category and directionality of interactions and communication activity were explored. (ERQ: V).

3.2 Subjects

A sample of 367 (126 males and 241 females), 15–17 years old college students was used to collect data about gaming tendencies. From this larger sample, 57 students, (20 males and 37 females) were assigned to fifteen experimental groups with varying number of members (3/4/5/6).

3.3 Procedure: Organising the setting and treatment

Surveys were first administered to collect data about participants' gaming tendencies. Using this data, treatment groups with different composition were set up using the following criteria: *gender* including male, female and mixed gender groups; *collective gaming competence* including 'Competent' groups (with enthusiastic gamers who played over 8 hours per week and listed above 5 game items as preferred games), 'Mixed' competence groups including two enthusiastic or moderate gamers (played between 2-7 hours per week and listed from 2-4 preferred games) and two non-gamers (play 0-1 hours per week and list 0-1 preferred games), 'Non-competent' groups including solely non-gaming participants; *level of friendship* including 'Friendly' groups where all participants show a degree of familiarity and camaraderie, 'Partly friendly' groups comprising two friends and two unknown participants (no friendship history), and 'Non-friendly' groups where all participants were new comers with no friendship history; *Collective gaming strategy* a group characteristic was assigned after analysing the recorded sessions on video where 'Guided' groups showed a gaming strategy led by leader, 'Collaborative' groups shared the leader role equally among group members, and 'Exploratory' groups had no established leader/s having members adopting an 'ad hoc' individualised approach to gaming, with little effort at coordinating group activity. Treatment groups were assigned different games according to specific instructional objectives discussed in section 3.4.

Sessions were recorded on video capturing student-student and student-computer interactions. Recorded sessions were analysed to quantify the type, frequency and directionality of interactions entering these in appropriate data sheets. This data was transferred to SPSS and analysed using appropriate statistical tools according to identified research questions.

3.4 The Games Used

Diverse interactive scenarios were created through the use of different games according to specific research objectives. *Alpha Centauri* was used for its scientific and technological orientation, *Empire Earth* for its evolutionary historical model and the attractive intermix between narrative and gameplay, *Mind Maze* as a quiz game for assessing knowledge in different content areas, *SIMS* for simulating human behaviour and relationships and *Need for Speed* as an action-oriented sports game that includes car design features.

4. DATA ANALYSIS AND RESULTS

Data was entered in SPSS using the appropriate codes for the various variables. Using mainly GLM Multivariate and ANOVA statistical tools interaction between group characteristics and clusters of interactions including separate TOIs, computed TOIs, separate POIs, computed positive POIs, computed negative POIs and total Communication Activity (ComAct), were investigated. The main experimental results are presented in the following section according to the identified empirical research questions (ERQ).

4.1 ERQ 1: Interactions in male, female and mixed gender groups

Statistical significance (s.s.) was obtained for 'Suggesting' ($p < 0.02$) in male groups and for 'Providing feedback' ($p< 0.001$) and 'Confirming' ($p< 0.067$) in female groups. No particular type of TOI was significant for mixed gender groups. 'Suggesting' implies an action from a participant directed to the game executor thus manifesting the 'Command' approach adopted by males during gaming. Female are more collegial with game executors asking for suggestions and colleagues providing feedback, which in turn is reciprocated by 'Confirming' expressions. The absence of s.s. for TOIs in mixed gender groups indicate restraining conditions arising from underlying conflicting gender-based approaches.

Male groups show no s.s. for single POI but show s.s. for summed Communication activity ($p< 0.047$) which include all task-related interaction. This indicates a greater orientation to tasks at hand, with less emphasis on interpersonal communication. Females show s.s. for 'Pleased Look' ($p< 0.000$), 'Jubilant' expressions ($p< 0.027$) and summed positive POIs ($p< 0.00$), definitely showing a more person-oriented approach with higher levels of interpersonal communication and expressions of positive feelings. The restrained climate prevalent in mixed gender groups is manifested through s.s. for 'Neutral look' ($p< 0.006$), expressions of 'Disapproval' ($p< 0.024$) and summed negative POIs ($p<0.00$). While males tend to interact at the task level, females emphasise more interpersonal communication. This tendency is confirmed by the directionality of interactions. Females tend to show higher frequencies for 'One-to-One' ($p< 0.032$) while males show s.s. for overall interactions ($p< 0.042$), including both one-to-one and one-to-all interactions. In both single gender groups interactions are more intense than in mixed gender groups. The restraining conditions in mixed gender groups is confirmed by the s.s. for same gender interactions – 'Male-to-Male' ($p< 0.038$), 'Female-to-Female' ($p< 0.000$) and 'Female-to-Females' ($p< 0.001$).

4.2 ERQ II: Interactions in groups with different gaming competence

Competent groups show more TOIs such as Confirming ($p < 0.069$) and 'Suggesting' ($p < 0.000$). Mixed competence groups show no s.s. for any TOI. Non-competent groups show reactive TOIs, including 'Focused Reception' ($p< 0.002$) and 'Providing feedback' ($p< 0.009$). No s.s. was achieved for computed TOIs implying that there is no significant difference between groups with different gaming competence. Thus a conglomeration of enthusiastic gamers does not translate into an efficient group with enhanced collective gaming competence.

At the socio-emotional level non-competent groups show high s.s. for positive POIs, summed pPOIs ($p < 0.000$), 'Pleased look' ($p < 0.000$) and 'Jubilant' expressions ($p < 0.002$). Mixed competence groups show high s.s. for negative POIs ($p < 0.000$) and 'Neutral look' ($p < 0.000$). Highly competent groups show s.s. for 'Disengaged' ($p < 0.001$) and total Communication activity ($p < 0.026$). Non-competent gamers are not hindered from communicating their feelings, complimenting each other even for minor contributions. This is confirmed by the direction of interactions. Non-competent groups show s.s. for Participant-Executor ($p < 0.056$), Male-Male ($p < 0.039$), Female-Female ($p < 0.008$) and Female-Females ($p < 0.009$).

As a result of conflicting levels of proficiency, gaming and communication are strongly hindered in mixed competence groups. This results in a dull and passive comportment by all. Lack of interaction in this category is also confirmed by the lack of s.s. for any directionality effect. Highly competent groups show diverging and contrasting reactions. Some competent participants stop contributing and disengage from the main group activity. Those that remain on task show increased communication activity and thus s.s. for 'Participant-to-Participant' ($p < 0.004$). These in-group reactions are further confirmed by the gaming roles adopted and the expressions of friendship. Competent groups show s.s. for the 'Guide' role ($p <0.041$) while mixed competence groups show s.s. for a 'Spectator' role ($p < 0.092$). Non-competent groups show no s.s. for any of the roles. In competent groups leadership is equally distributed so that participants adopt a collaborative rather than a managerial approach. Their interactions are characterised by suggesting and confirming rather than directing others. The inhibiting conditions in mixed competence groups compel participants to adopt a passive, spectator role. Non-competent groups are active and focussed on task but show no defined roles. No one is assertive enough to assume a 'leader' or 'guide' role.

Regarding level of friendship competent groups show a highly significant interaction for the lowest level of friendship - 'Detached' ($p < 0.000$), while mixed competence groups show s.s. for 'Solitary' comportment ($p < 0.003$). Competent gamers tend to manifest no intermediate comportment. They are either in or out of

the game. When some take the lead others tend to disengage. This is not the case with mixed competence groups where participants not actively contributing to the group process still monitor the game actively. Non-competent groups show a more heterogeneous comportment with no particular tendency for any friendship level.

4.3 ERQ III: Interactions in groups with different combinations of friendship.

The s.s. for 'Providing feedback' ($p < 0.002$), 'Confirming' ($p < 0.002$), 'Suggesting' ($p < 0.000$) indicate that friendly groups are more oriented to interpersonal interaction. Partly friendly groups show s.s. for 'Responding' ($p < 0.049$), 'Sharing' ($p < 0.000$) and 'Total TOIs' ($p < 0.007$) indicating their tendency to remain more at the task level, focussing on the game while interacting much less with others. Non-friendly groups show no s.s. for any TOIs interactions, an indication of the underlying restraining conditions. This trend is confirmed by the socio-emotional level and directionality of interactions. Friendly groups show s.s. for 'Pleased look' ($p < 0.007$), 'Total positive POIs' ($p < 0.005$), 'Total Communication Activity' ($p < 0.000$), 'One-to-one' ($p < 0.001$), 'Male-Male' ($p < 0.04$) and 'Female-Female' ($p < 0.000$) interactions. This contrasts with the atmosphere that develops in the other groups. Partly friendly groups show a more pessimistic tendency, communicating negative task-related feelings: 'Disapproving' ($p < 0.002$), 'Censures game' ($p < 0.000$) and 'Total negative POIs' ($p < 0.028$). They tend to be anonymous in POIs, showing s.s. for 'One-to-All' ($p < 0.000$) and 'Male-to-All' ($p < 0.002$). Non-friendly groups show s.s. for 'Neutral look' ($p < 0.01$) showing emotional inertness and disengagement. This is further confirmed by the 'Solitary' ($p < 0.000$) personal friendship level.

Group composition by friendship level determines individual roles adopted by participants. Friendly groups tend to develop a collegial climate that distributes roles evenly with individual roles fluctuating between 'Guide' ($p < 0.033$) and 'Supporter' ($p < 0.002$) showing frequent 'Participant-to-Executor' ($p < 0.002$) interaction. Non-friendly groups show no s.s. for any individual gaming roles which implies a less defined group structure, shown by the most basic 'Participant-to-participant' direction of interactions ($p < 0.012$). The discreet comportment of Non-friendly groups is manifested mainly through a 'Spectator' role ($p < 0.000$). Gaming activity in these groups is characterised by 'ad hoc' in-group formations where one participant assumes an executor role with another temporarily assuming a leading one. Thus while the other members are passive 'Spectators', sporadic 'Executor-to-leader' interaction ($p < 0.025$) can be observed.

4.4 ERQ IV: Interactions in groups with a leader versus without a leader.

Groups with an established leader show no s.s. for any of the TOIs implying a wider repertoire of interactions with no special emphasis on any. 'Exploratory' groups show s.s. just for 'Responding' ($p < 0.007$) implying that these groups lack dynamic organisation and tend to adopt a 'trial and error' improvised strategy with some participants responding to these 'ad hoc' suggestions. Collaborative groups have a distributed leading role and thus tend to show more 'Sharing' ($p < 0.079$) and 'Interacting with Game' ($p < 0.089$). 'Guided' groups show a distributed pattern of interactions with no special emphasis on any TOIs. Their collegial approach gives more space for interpersonal dissonance showing a higher level of 'Disapproving' ($p < 0.008$) and 'Negative POIs' ($p < 0.068$) interactions. The exploratory approach of non-competent groups tends to be reactive with s.s. for 'Responding' and 'Approving' ($p < 0.000$) any proposed action. The frequent superfluous compliments explain the s.s. for 'Positive POIs' ($p < 0.028$) and enhanced 'Communication activity' ($p < 0.056$) of these groups.

Directions of interactions in guided groups are diffused and varied showing no s.s. for direction type, individual gaming role and individual expressions of friendliness. Leaders do not structure but organise interactions without limiting variety. The distributed role of leaders in collaborative groups emphasises 'Participant-to-leader' interaction ($p < 0.075$) and thus 'Supporter' ($p < 0.024$) individual gaming role. The collegial approach develops a 'Friendly' climate ($p < 0.051$). The unorganised interaction pattern in exploratory groups is manifested through s.s. for 'One-to-all' ($p < 0.001$) and 'Participant-Participant' ($p < 0.024$) directions and a tendency to adopt a 'Spectator' role ($p < 0.076$) with the corresponding 'Solitary' level of friendship ($p < 0.061$).

4.5 ERQ V: Interactions and group size

Data analysis for TOIs reveals a smooth transition from active to more passive interaction with increase in group size. Participants in 3-person groups are very alert and focussed on task – 'Focussed reception' ($p < 0.042$) and 'Interacting with Game' ($p < 0.044$). The directionality of their interactions confirms this enhanced activity by showing s.s. for 'One-to-one' ($p < 0.015$), 'Total Interactions' ($p < 0.000$), 'Participant-to-executor' and 'Female-to-females' ($p < 0.002$). In 4-person groups the emphasis shifts from the game task to group process showing s.s. for 'Sharing', especially through male anonymous 'Male-to-All' ($p < 0.019$) interactions. In 5 and 6-person groups participants tend to adopt a more passive role most of them 'Providing feedback' ($p < 0.013$) and 'Confirming' ($p < 0.053$). This trend precludes groups from showing a range of TOIs and thus no s.s. for 'Computed TOIs' ($p < 0.517$). These larger groups tend to sub-group and become more anonymous. 5-person groups show a tendency to have bi-directional 'Leader-Executor' ($p < 0.004$) and 'Executor-Leader' ($p < 0.07$) interactions and show 'Exclusive' friendship comportment ($p < 0.025$). 6-person groups find it more difficult to maintain organised collective activity. They tend to be anonymous in their interactions – 'One-to-All' ($p < 0.000$) and 'Female-to-all' ($p < 0.001$) and also form in-group formations as shown by the enhanced 'Participant-to-participant' ($p < 0.000$) interactions. They also show significant levels of detachment ($p < 0.03$).

The socio-emotional climate of these groups re-affirms the transition from positive to negative POIs as a function of group size. 3-person groups show s.s. for 'Jubilant' ($p < 0.000$) and 'Summed Positive POIs' ($p < 0.028$). 4-person groups develop a negative climate characterised by 'Disapproving' ($p < 0.002$), 'Censuring game' ($p < 0.015$) and 'Summed negative POIs' ($p < 0.013$). Detachment characterises larger groups with 5-person groups showing s.s. for 'Neutral look' ($p < 0.031$) and 'Disengaged' ($p < 0.028$) for 6-person groups.

5. CONCLUSION

When designing collaborative game-based learning, it is important to control the various group-related factors. A methodology that organises collaborative gaming using interaction profiles including type, frequency and directionality of interactions should be advocated. When setting up groups it is important to avoid setting up mixed gender groups. Male groups should be challenged to communicate more with their colleagues during gaming and female groups to limit interpersonal communication and focus more on task. It is not suggested to set up mixed competence groups. Non-competent groups should have a competent person to manage the gaming task or provide support by giving more detailed task description. Competent groups should have a leader to manage group processes, integrating those who tend to disengage. Group history and level of friendship are important criteria for setting up groups. Friendly groups should be advised to balance POIs emphasising TOIs. Being so conducive to sub-grouping and interference with task, setting up of groups with a balanced mix of friendly participants should be avoided. A person should be delegated to promote a friendly atmosphere with non-friendly groups, using the game context to make participants more relaxed and open to contribution. Group history should be developed through reference to preliminary settings or by organising off task activities. A collaborative gaming strategy should be used according to specific instructional objectives. A guided strategy should be employed when using collaborative gaming to promote domain knowledge and skills. A leader should be assigned or appointed by the group. A more collaborative approach is recommended when using games for developing personal and social skills. In any of these strategies the ideal group size is 2 or 3 members.

It seems that gaming, like any type of instructional template, offers optimal learning conditions if there is maximal appeal to individual students. In contrast to earlier studies that have articulated the value of heterogeneity for collaborative learning, Nijhof & Kommers (1985), it seems that the aspect of internalisation of gaming is rather problematic demanding optimal conditions to exert any influence on individual knowledge and skills.

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