6.0 UNDERSTANDING THE MALAYSIAN PUBLICS' NEEDS AND INTEREST ON BIOTECHNOLOGY

This chapter discusses the levels of biotechnology understanding, areas of interest, sources of information, satisfaction of media coverage of biotechnology news, credibility of sources of information, and the motivation to have an understanding of biotechnology, amongst the Malaysian publics. For the research Malaysian publics were categorised into general public (n=105), general public who visited MyBio Carnival (n=245), school students (n=410), school students who visited MyBio Carnival (n=109), university students (n=398), and teachers (n=257). The total number of publics surveyed was 1524.

Analysis of this data is important to develop a robust and effective biotechnology communication strategy and can form the basis of effective evaluation methodology. This is in accordance with the assertion of Falk et. al. (2007) where analysis of where, when, why and with whom people learn science should form the basis of any science communication effort, and certainly ought to guide how the success of the varied efforts to educate the public is measured. Falk et. al. believe that to communicate and teach about science effectively, it should be done in a language and a form that people are willing to listen to, which means knowing where people tend to learn about science, why they pay attention to the topic, and how they stay engaged in science throughout their lifetimes. Descriptive analysis has been used to analyse these parameters, that are used in developing the biotechnology communication strategy for Malaysia. The questionnaire is appended in Appendix II.

6.1 LEVEL OF UNDERSTANDING OF BIOTECHNOLOGY AMONG MALAYSIAN PUBLICS

Table 6.0: Descriptive Analysis of Level of Understanding of Biotechnology across Public Groups

		Do you understand the term biotechnology enough to explain to a friend?			
		Yes	**No**	**A Little**	**Total**
Public	Count	38	23	44	105
	% within target	36.2	21.9	41.9	100
	% within level of understanding	8.1	7.9	5.8	6.9
Public at MyBio Carnival	Count	86	38	121	245
	% within target	35.1	15.5	49.4	100
	% within level of understanding	18.4	13.0	15.8	16.1
School students	Count	83	92	235	410
	% within target	20.2	22.4	57.3	100
	% within level of understanding	17.7	31.5	30.8	26.9
School students at MyBio Carnival	Count	24	40	45	109
	% within target	22.0	36.7	41.3	100
	% within level of understanding	5.1	13.7	5.9	7.2
University students	Count	107	81	210	398
	% within target	26.9	20.4	52.8	100
	% within level of understanding	22.9	27.7	27.5	26.1
Teachers	Count	130	18	109	257
	% within target	50.6	7.0	42.4	100
	% within level of understanding	27.8	6.2	14.3	16.9
Total	Count	468	292	764	1524
	% within target	30.7	19.2	50.1	100
	% within level of understanding	100	100	100	100

Respondents were first asked to self-rate their understanding of biotechnology by asking them if they understood the term biotechnology enough to explain it to a friend. Based on the descriptive statistical analysis presented in Table 6.0, among those who responded as being able to explain biotechnology to a friend, teachers were the highest with 27.8 per cent of the "Yes" responds, followed by university students (22.9%), general public at MyBio Carnival (18.4%), school students (17.7%), general public (8.1%) and finally the school students at MyBio Carnival (5.1%). In terms of the lowest understanding of biotechnology, school students came the top with 31.5 per cent of the "No" answers coming from them, which indicated that they are not exposed to biotechnology education in schools. This is followed by university students (27.7%),

school students at MyBio Carnival (13.7%), general public at MyBio Carnival (13%), general publics (7.9%) and finally teachers (6.2%). A study by Amin (2007) indicated that those with higher levels of education tend to have better knowledge of biotechnology, which concurs with the funding of this survey.

A previous study by Malaysian Science and Technology Information Centre (MASTIC, 2005) has shown that the awareness level of Malaysian publics on modern biotechnology is on the rise. In 1996, 17 per cent of the general public surveyed had heard of genetic engineering, which increased to 33.8 per cent in 1998, and 42.4 per cent in 2000. By 2004, this figure rose to 56.1 per cent. A survey conducted by Juanillo (2003) in 2002, indicated Malaysian stakeholders (consumers, businessmen, extension workers, farmer leaders, journalists, policymakers, and scientists), with the exception of scientists, assessed their understanding of biotechnology to be moderate to slightly moderate at an overall mean rating of 4.16 (out of total mean score of 7.00). However, a later study by Amin et. al. (2007) showed the awareness and knowledge level of general public in Klang Valley to be low (3.88 out of total mean score of 9.0) and moderate (4.70 out of total mean score of 9.0) respectively. Another study by Amin et. al. (2011) indicated an increase in awareness level among general public in Klang Valley. The overall mean score rose to 5.06 between 2010 and 2011. Due to the different methods used to measure level of awareness, knowledge and understanding by these researchers, it is difficult to compare all these results with the results from this research. Juanillo (2003) required respondents to self-rate their level of understanding using a scale of 1-7, whereas this in this research, respondents chose "Yes", "A little", or "No" to indicate their level of biotechnology. The MASTIC (2005) and Amin et. al. (2007 and 2011)'s researches gauged respondents level of understanding through their responses to questions related to biotechnology. However, based on Amin et. al. (2007

and 2011)'s results, it could be concluded that there is an increase in the level of awareness among general public in Klang Valley.

Amin et. al. (2011) attributed the increase in awareness level to the increase in public awareness programmes by several biotechnology communicators such as MABIC and the Ministry of Natural Resources and Environment (NRE). Since the launch of the National Biotechnology Policy in 2005, there has been a lot of media attention on this sector and BiotechCorp also took a proactive role in promoting public understanding of biotechnology.

Table 6.1: One-way ANOVA to compare level of understanding of biotechnology across public groups

	Sum of Squares	Df	Mean square	F-value	Significance
Between groups	44.275	5	8.855	19.330	.000
Within groups	695.399	1518	0.458		
Total	739.675	1523			

Analysis of Variance (ANOVA) was significant for the comparison of levels of understanding of biotechnology (F=19.33, p<0.05) across publics groups. Results depicted in Table 6.1, indicated that the differences between groups in terms of understanding biotechnology is significant (F=19.33, P<0.05).

6.2 AREA OF INTEREST ON BIOTECHNOLOGY AMONG MALAYSIAN PUBLICS

Table 6.2: Area of Interest in Biotechnology among Malaysian Publics

Areas in biotechnology	Frequency	%
Agriculture	421	27.6
Medical	771	50.6
Industry	213	14.0
Environment	469	30.8
None	114	7.5

Note: Since the respondents can choose more than one area, the total number of respondents is higher than the sample size (N=1524).

Respondents were asked to choose their areas of interest in biotechnology with choices of agriculture, medical, industry, environmental, or none. Table 6.2 indicates that among all respondents, the highest percentage of biotechnology interest is in Medical, where 50.6 per cent of the respondents are interested in this field. In order of ranking, Environment (30.8%) was the second field of interest followed by Agriculture (27.6%), Industry (14%) and the lowest was 'None' (7.5%). This shows that Malaysian publics tend to profess interest in one or another area of biotechnology. A similar trend is shown in Europe where two areas of greatest interest were medicine and environmental biotechnology (Gouthier, 2005).

Newspapers giving more prominence to medical and healthcare news show that journalists and editors understand the needs and interest of the general public. This also points to news value or newsworthiness, where media portrays news that is relevant and of interest to the readers or the public. However, there is a question of whether media coverage of medical and healthcare news drives public interest in this field. Media's role in driving public interest merits further study that could be attempted by other researcher. This would help to increase public interest in areas that are not very popular such as agriculture and industrial biotechnology.

Results from this survey showed that only 7.5 per cent were not interested in any biotechnology field. Thus, lack of interest among the public should not pose a challenge to biotechnology communicators. A good communication strategy, choice of media, and messages should be able to engage Malaysian publics with biotechnology. It is imperative for communicators to understand public needs and attitudes. This also stresses the fact argued by Lévy-Leblond (1992) that "scientific understanding of publics" is just as important as "public understanding of science". Public understanding

of science or biotechnology can only be achieved if the scientific community understands the public, their interests and attitudes.

Table 6.3: Area of Interest in Biotechnology across Malaysian Publics

Publics	Agri		Medical Biotech		Industrial Biotech	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
General Public	39	37.1	42	40	13	12.4
General Public at MyBio carnival	47	19.2	170	69.4	37	15.1
School Students	70	17.1	215	52.4	33	8.0
Schools Students at MyBio carnival	12	11.0	39	35.8	17	15.6
University Students	93	23.4	203	51.0	85	21.4
Teachers	160	62.3	102	39.7	28	10.9

Table 6.3a: Area of Interest in Biotechnology across Malaysian Publics

Publics	Environmental Biotech		None	
	Frequency	**%**	**Frequency**	**%**
General Public	38	36.2	10	9.5
General Public at MyBio carnival	67	27.3	13	5.3
School Students	113	27.6	38	9.3
Schools Students at MyBio carnival	41	37.6	11	10.1
University Students	125	31.4	34	8.5
Teachers	85	33.1	8	3.1

Interest areas among the segmented Malaysian publics in biotechnology show much commonality (Table 6.3, 6.3a), with medical biotechnology being the most favourite. General public (40%), general public at MyBio Carnival (69.4%), school students (52.4%), and university students (51%) chose Medical Biotechnology as their first field of interest. The exception was for school students at MyBio Carnival and teachers, who respectively chose Environmental Biotechnology (37.6%) and Agricultural Biotechnology (62.3%) as their fields of interest. All target groups indicated their interest in biotechnology, as the smallest number in all groups chose "none" as their response. The second most field of interest was Environmental Biotechnology among

most target groups with the exception of general public, school students at MyBio Carnival, and teachers. For general public, Agricultural biotechnology (37.1%) was the second most popular choice; for school students at MyBio Carnival and teachers, medical biotechnology is the second choice (35.8% and 39.7% respectively).

Environmental and agricultural biotechnology interchangeably became the 2nd and 3rd fields of interest. However, all target groups chose Industrial Biotechnology as their least field of interest, with the exception of students at MyBio Carnival who chose Agricultural Biotechnology (11%). Public interest in medical and healthcare is not solely Malaysian phenomenon, as research by the Office of Science and Technology and Wellcome Trust (2001) also showed that almost all respondents were interested in health issues and medical discoveries (91 and 87% respectively).

Juanillo's (2003) survey in 2002 indicated an overall mean interest in biotechnology by Malaysian stakeholders were at 5.33 out of total score of 7.00, which is a moderate to high level. Juanillo (2003) attributes this to the country's thrust for modernisation through science and technology.

Understanding public interest will help biotechnology communicators to craft their messages and strategies according to relevance to the public, in order to obtain their attention and engagement. The other areas such as agricultural and industrial biotechnology are of priority to Malaysian biotechnology sector as stipulated under the National Biotechnology Policy (2005). More innovative strategies should be employed to garner public interest and engagement. It must be acknowledged that while the majority cite medical biotechnology as their area of interest, there is still a significant level of interest in other areas of biotechnology.

6.3 SOURCE OF INFORMATION FOR MALAYSIAN PUBLICS ON BIOTECHNOLOGY

Table 6.4: Descriptive Analysis of Source of Biotechnology Information across Public Groups

Publics	Newspapers				Television			
	Yes		No		Yes		No	
	Fr	%	Fr	%	Fr	%	Fr	%
General Public	49	46.7	56	53.3	37	35.6	67	64.4
General Public at Carnival	99	40.4	146	59.6	61	25.0	183	75.0
School Students	186	45.4	224	54.6	221	54.0	188	46.0
School students at Carnival	26	23.9	83	76.1	45	41.3	64	58.7
University Students	174	43.7	224	56.3	146	36.7	252	63.3
Teachers	169	65.8	88	34.2	218	84.8	39	15.2

Table 6.4a: Descriptive Analysis of Source of Biotechnology Information Across Public Groups

Publics	Radio				Internet			
	Yes		No		Yes		No	
	Fr	%	Fr	%	Fr	%	Fr	%
General Public	4	3.8	101	96.2	54	51.4	51	48.6
General Public at Carnival	10	4.1	235	95.9	106	43.4	138	56.6
School Students	38	9.3	372	90.7	208	50.7	202	49.3
School students at Carnival	8	7.3	101	92.7	42	38.5	67	61.5
University Students	24	6.0	374	94.0	226	56.9	171	43.1
Teachers	43	16.7	214	83.3	117	45.5	140	54.5

Table 6.4b: Descriptive Analysis of Source of Biotechnology Information Across Public Groups

Publics	Science Centres				Others				Total
	Yes		No		Yes		No		
	Fr	%	Fr	%	Fr	%	Fr	%	
General Public	14	13.3	91	86.7	15	14.3	90	85.7	105
General Public at Carnival	51	21.0	192	79.0	21	8.6	224	91.4	245
School Students	99	24.1	311	75.9	11	2.7	399	97.3	410
School students at Carnival	48	44.0	61	56.0	7	6.4	102	93.6	109
University Students	63	15.9	334	84.1	47	11.8	350	88.2	397
Teachers	67	26.1	190	73.9	0	0	257	100	257

Although public sources for acquiring knowledge and information on biotechnology are multiple, the common ones are newspapers, television, radio, internet, science centres and other sources. This information is important for biotechnology communicators to choose their mode of communication that could effectively reach the publics. From

results presented in Table 6.4, 6.4a and 6.4b, the top three source of biotechnology information appear to be television, internet and newspapers, and the last three are science centres, others and radio. From the surveys, the respondents indicated others as friends, family members and schools. For the general public and general public at the carnival, there is no major difference in their source of biotechnology information. The order of preference is internet, newspaper, and television. The least preferred choice is radio. The only difference is the general public at the carnival preferred science centres to other sources as fourth choice. This is obvious as this section of public tends to be those who frequent science centres and exhibitions. They are the attentive public who are more likely sensitive to, and interested in biotechnology.

It is also interesting to note that the only difference among school students and school students who participated in the carnival is that for those at the carnival, science centres were the first choice. Again, the reason is likely the same as these students are an attentive audience who seek information from science centres and exhibitions. Otherwise the order of preference is television, internet, newspapers, radio and others.

For university students, internet topped the list with 56.9 per cent using this as the main source, followed by newspaper (43.7%), television (36.7%), science centres (15.9%), and finally radio (6%). For teachers, television came first with 84.8 per cent, followed by newspapers (65.8%), internet (45.5%), science centres (26.1%), and radio (16.7%). Surprisingly, teachers do not have any other source of information. Though, the impact of internet was not covered in this study, it cannot be denied that internet is encroaching as one of the most powerful media in reaching out to the public. Jones and Stein (2005) reported that in the USA in 1997, the internet was not in the radar screen of most people; by 2000 learning from the internet had surpassed radio. The authors presumed

that the internet has continued to gain in importance, though it has yet to surpass resources such as books, broadcast media and formal education. Ten Eyck (2005) observed that in the USA, internet seems to be more frequently used than some traditional media to learn about biotechnology. Scearce (2007) reported that the internet is the only information source that has been steadily attracting larger audiences to science and technology information in the past few years.

In Malaysia internet usage increased to 41 per cent in 2012 from 25 per cent in the previous year according to the latest findings of Nielsen Mobile Insight Malaysia 2010 report. The highest internet usage was recorded among people aged 20-24, who represent 57 per cent of the total internet users, and this group spends on an average 22.3 hours online per week. The findings from this study showed that internet is a favourite source of information for all sectors of the public, and based on the high internet usage in Malaysia, an opportunity exists to capitalise internet as an important media for engaging with the public. Credible information from university scientists available to consumers on the internet has the potential to impact biotechnology awareness (Fritz, S. et. al., 2012). Therefore, internet should be included as a potential media by all biotechnology communicators in Malaysia, as it is worth the effort to capitalise on the interests of this growing audience. The versatility of the internet as a tool of communication should be easily exploited by scientists, universities, research institutes, and NROs.

Previous studies by ISAAA-UIUC (2003) and Amin (2007) showed the most frequently used sources of information on biotechnology by Malaysian stakeholders are the mass media (television, newspaper and radio), followed by people, including family and friends. The results from this research differ with radio not being a favourite media.

Juanillo (2003) who conducted a survey on public understanding, perceptions, and attitudes towards agricultural biotechnology in Malaysia revealed media (radio, television, and newspapers) as the most important sources of information for the public, followed by books, family and friends, and finally experts/professional or scientists.

A similar finding was observed in the USA (Ten Eyck 2005). Of the 855 individuals polled, 58 per cent mentioned television as their main source of biotechnology information. The lowest ranking category was family and friends (12%).

6.4 LEVEL OF SATISFACTION ON MEDIA COVERAGE ON BIOTECHNOLOGY

Table 6.5: Descriptive Analysis of Level of Satisfaction on Media Coverage of Biotechnology among Malaysian Publics

Media	Low		Moderate		High	
	Fr	%	Fr	%	Fr	%
Newspaper	418	27.4	932	61.2	173	11.4
Television	374	24.5	817	53.6	331	21.7
Radio	1142	74.9	352	23.1	27	1.8

Table 6.6: Descriptive Analysis of Level of Satisfaction on Biotechnology Coverage in Newspaper across Malaysian Publics

Publics	Low		Moderate		High	
	Fr	%	Fr	%	Fr	%
General Public	42	40.0	56	53.3	7	6.7
General Public at MyBio Carnival	62	25.3	156	63.7	27	11.0
School Students	115	28.0	242	59.0	53	12.9
School Students at MyBio Carnival	47	43.1	47	43.1	15	13.8
University Students	98	24.6	248	62.3	51	12.8
Teachers	54	21.0	183	71.2	20	7.8

Table 6.7: Descriptive Analysis of Level of Satisfaction on Biotechnology Coverage on Television across Malaysian Publics

Publics	Low		Moderate		High	
	Fr	%	Fr	%	Fr	%
General Public	38	36.2	56	53.3	11	10.5
General Public at MyBio Carnival	93	38.0	119	48.6	32	13.1
School Students	66	16.1	216	52.7	128	31.2
School Students at MyBio Carnival	16	14.7	58	53.2	35	32.1
University Students	124	31.2	214	53.8	59	14.8
Teachers	37	14.4	154	59.9	66	25.7

Table 6.8: Descriptive Analysis of Level of Satisfaction on Biotechnology Coverage on Radio across Malaysian Publics

Publics	Low		Moderate		High	
	Fr	%	Fr	%	Fr	%
General Public	75	71.4	25	23.8	5	4.8
General Public at MyBio Carnival	183	74.7	54	22.0	7	2.9
School Students	317	77.3	85	20.7	8	2.0
School Students at MyBio Carnival	72	66.1	30	27.5	6	5.5
University Students	310	77.9	86	21.6	1	0.3
Teachers	185	72.0	72	28.0	0	0.0

Table 6.9: Descriptive Analysis of Mean Score of Level of Satisfaction on Media Coverage on Biotechnology across Malaysian Publics

Publics	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Public	105	4.7429	1.43466	0.14001	4.4652	5.0205
Public at MyBio Carnival	245	4.8735	1.34451	0.08590	4.7043	5.0205
School Students	410	5.2463	1.24122	0.06130	5.1258	5.3668
School Students at MyBio Carnival	109	5.2569	1.40372	0.13445	4.9904	5.5234
University Students	398	4.9271	1.26261	0.06329	4.8027	5.0516
Teachers	257	5.2607	1.12766	0.07034	5.1222	5.3992
Total	1524	5.0715	1.28408	0.03289	5.0070	5.1360

The information on the public's level of satisfaction in the different media that cover biotechnology information is important as communicators can use this information to choose appropriate media for communicating biotechnology, or improve the effectiveness of the less-efficient media. Based on results shown in Table 6.5, most of the publics surveyed indicated newspapers (21.7%) as having the highest level of

satisfaction of media coverage on biotechnology, followed by television (11.4%) and the lowest is radio (1.8%). This is consistent with the preferred source of information, with newspaper and television being two top sources, and radio being one of the last three among the surveyed sources. There is also consistency in the rating of newspaper among all the categories, where the media coverage given by newspaper for biotechnology had been rated as moderate. The same is also apparent for television (Table 6.7), where the highest number in all categories rated television coverage on biotechnology as moderate. Radio (Table 6.8) also received the same rating from all categories, which has been rated as low in terms of media coverage given to biotechnology.

Teachers were the most satisfied group with 71.2 per cent rating newspaper's coverage on biotechnology as moderate (Table 6.6). Teachers were also the most satisfied with television's coverage on biotechnology, with 59.9 per cent rating it as moderate. School students and school students at carnival were among those who rated television as high in terms of media coverage with 31.2 per cent and 32.1 per cent respectively. However, no media was given high rating beyond 50 per cent from any of the publics category. Those who rated newspaper as high ranged from 6.7-13.8 per cent, whereas for television was 10.5-32.1 per cent, and radio 0-5.5 per cent. This puts television as the most effective media to disseminate information on biotechnology.

From the survey, radio emerged as the least effective media with the majority rating it as low (66.1-77.9%). This also corresponds to the earlier question on where publics acquire information on biotechnology, where radio emerged as the least preferred media. Thus, radio is not currently playing an effective role in disseminating

biotechnology information and it has to be improved if communicators choose radio as their medium for biotechnology communication.

Table 6.10: One-way ANOVA to compare the level of satisfaction on media coverage on biotechnology across public groups

	Sum of Squares	Df	Mean square	F-value	Significance
Between groups	54.723	5	10.945	6.763	0.000
Within groups	2456.482	1518	1.618		
Total	2511.204	1523			

ANOVA was significant for the comparison of level of satisfaction on media coverage on biotechnology (F=6.763, p<0.05) across publics groups. Results depicted in Table 6.10, indicated that the differences between groups is also significant (F=6.763, P< 0.05).

6.5 CREDIBILITY OF SOURCE OF INFORMATION

Table 6.11: Credibility of Source of Information for Biotechnology among Malaysian Publics

Source of information	Frequency	%
Media	975	64
Scientists	550	36.1
NGO	245	16.1
Industry	189	12.4
Government	245	16.1
Others	49	3.2

Note: Since the respondents can choose more than one area, the total number of respondents is higher than the sample size (N=1524).

The importance of public trust in relevant institutions or biotechnology communicators cannot be ignored, as this contributes to public resistance and acceptance, and risk perception of biotechnology applications. Judgment about riskiness of new technologies such as bioengineered foods involves judgments about trustworthiness of scientists and their employers (Priest, 2001). To understand the publics' trust in biotechnology communicators in Malaysia, they were asked whom they see as credible source of information on biotechnology. This information will serve as a guide to biotechnology

communicators as to whom they could use as their spokesperson and champions to relay their messages and information on biotechnology. From Table 6.11, the majority of Malaysian publics see media (64%) as the most credible source of biotechnology information, followed by scientists (36.1%), NGO and government (16.1%), industry (12.4%) and finally others (3.2%), which comprises of friends, families and peers.

Table 6.12: Credibility of Source of Information for Biotechnology among Malaysian Publics based on Public Categories

Publics	Media		Scientists		NGO	
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**
General Public	62	59.0	41	39.0	17	16.2
General Public at MyBio carnival	137	55.9	97	39.6	56	22.9
School Students	307	74.9	120	29.3	44	10.7
Schools Students at MyBio carnival	49	45.0	45	41.3	21	19.3
University Students	217	54.6	161	40.5	77	19.3
Teachers	203	79	86	33.5	30	11.7

Table 6.12a: Credibility of Source of Information for Biotechnology among Malaysian Publics based on Public Categories

Publics	Industry		Government		Others	
	Frequency	%	Frequency	%	Frequency	%
General Public	14	13.3	23	21.9	5	4.8
General Public at MyBio carnival	39	15.9	50	20.4	15	6.1
School Students	21	5.1	36	8.8	11	2.7
Schools Students at MyBio carnival	9	8.3	8	7.3	3	2.8
University Students	80	20.1	67	16.8	13	3.3
Teachers	26	10.1	61	23.7	2	0.8

For general public, the third most credible source of information was government (21.9%), and for university students, the third most credible source was industry (20.1%). For all other publics categories, NGOs were the third most credible source of information. Between industry and government, the majority preferred government,

with the exception of school students at carnival (8.3%) and university students (20.1%) who prefer industry.

These results show some similarity with the survey carried out by Juanillo (2003) in 2002, where university scientists and science magazines ranked high amongst the top three possible sources of information considered as trustworthy by stakeholders. Websites were cited next by most stakeholders. The other source of information in order of ranking were private sectors scientists, NGOs, newspapers, television, radio, agri-biotech companies, religious groups, and family. Results from this research and Juanillo's survey show industry and family are at the bottom of the list, whereas, scientists, NGO and media have higher credibility. Although the order of scientists, NGO and media is not the same in both the surveys, these three sources are clearly highly trusted sources by the public.

According to the UK Office of Science and Technology and Wellcome Trust (2001), people tend to place their trust in sources that are perceived as neutral and independent. People trust university scientists, scientists working for research charities or health campaigning groups, and television news and documentaries. The next rank of trusted sources is those that are seen to have a degree of vested interest, such as environmental groups. There is similarity between this observation and the Malaysian publics, with scientists ranking the second order of credibility. However, media ranks first for Malaysian publics, whereas in Britain, newspapers are the least trusted source. Industry is also the one of the least trusted sources in the UK and this could be due to them not being perceived as neither neutral nor independent.

In the USA too industry came in the bottom of the list with 44.4 per cent trusting it to tell the truth, shown in the poll conducted by Ten Eyck (2005) with 855 respondents. University scientists were voted as the most trustworthy source. Government spokespersons were rated tenth with 44.8 per cent voting them as trustworthy. Again a similarity was seen between the USA and Malaysian publics, where scientists were at the top of the credibility ladder and industry at the lower rung. Environmental groups came sixth in the USA, with 64 per cent voting them as trustworthy. This is similar trend to Malaysia, scientists at top, industry at the bottom, and NGO and government in between.

A number of previous studies have indicated media as the powerful tool that shape public opinion on biotechnology (Nisbet and Lewenstein, 2002), and as an important source for news about science and technology (Malone et. al., 2000; Nelkin, 1995). Results from this study concur with the previous studies with media emerging as the most credible source of biotechnology information. Public trust is a valuable commodity (Priest, 2001) and it appears from this research that Malaysian scientists have earned public trust which will allow them to shape public opinion. Since public response to science and technology depends in part on how relevant institutions are perceived (Priest, 2001), the high public trust enjoyed by scientists could be leveraged to engage the public, shape public opinion and enhance their understanding of biotechnology. Scientists should be active biotechnology communicators given the fact that the public is able to connect to them based on the results of this research. Both media and scientists should play a crucial role in public understanding of biotechnology, and be used to help create citizens who will remain as interested audience of biotechnology, especially among the younger generation who is expected to

take up careers in biotechnology to support the agenda of National Biotechnology Policy.

With government as the third most trusted biotechnology communicators, they have a role to play in informing policy-related matter to the public. Public understanding of biotechnology-related policies is equally important to ensure public support towards government initiatives to make Malaysia a more substantial biotechnology player.

6.6   THE MOTIVATION FOR MALAYSIAN PUBLICS TO UNDERSTAND BIOTECHNOLOGY

Understanding the motivation for why publics seek knowledge on biotechnology will help develop biotechnology communication strategies and messages that are relevant to them. It will also help communicators to craft different messages for different audience, according to their needs. To achieve this, respondents were requested to choose their reasons for a good understanding of biotechnology using a scale of 1-10, with 10 being the highest priority. The reasons given were:

i)   to be able to make well-informed decisions on nutrition, medical needs, and environmental care;

ii)   to be able to inculcate the interest on biotechnology among our children; to be able to participate in government policies/direction and provide input; and

iii)   to take advantage of the business opportunities in this sector.

Table 6.13: Total Mean Statistics for the motivation to understand biotechnology

Motivation to understand biotechnology	N	Min	Max	Mean	Std. Deviation
To make well-informed decisions on nutrition, medical needs, environmental care	1524	.00	10.00	7.7343	2.70373
To ensure we are able to inculcate the interest on biotechnology among our children	1524	.00	10.00	6.7139	2.79495
To ensure we are able to participate in government policies/direction and provide input	1523	.00	10.00	6.5456	2.89950
To take advantage of the business opportunities in this sector	1524	.00	10.00	1.2382	2.67187

Table 6.13 shows the most important motivation for Malaysian publics to understand biotechnology was to be able to make well-informed decisions on nutrition, medical needs, and environmental care, with a mean of 7.7343. Whereas, the least priority for the publics to seek knowledge on biotechnology was to take advantage of business opportunities in this sector, with a mean of 1.2382.

Table 6.14 shows the reasons or motivation for Malaysian publics to seek to understand biotechnology. There is a common trend among the general public, school students, school students at carnival, and teachers, where their reasons were (in order): to be able to make well-informed decisions on nutrition, medical needs, and environmental care; to be able to inculcate the interest on biotechnology among our children; to be able to participate in government policies/direction and provide input; and to take advantage of the business opportunities in this sector. For the general public at carnival and university students, the order was similar with an interest in participating in government policies/direction and provide input superseding the ability to inculcate the interest on biotechnology among our children.

Table 6.14: The Mean Comparisons on the motivation to understand biotechnology among Malaysian Publics

		N	Mean	Min	Max
To make well-informed decisions on nutrition, medical needs, environmental care	Public	105	7.1524	.00	10.00
	Public + Carnival	245	6.3306	.00	10.00
	School Students	410	8.3000	1.00	10.00
	Students + Carnival	109	6.8349	1.00	10.00
	university students	398	8.2010	1.00	10.00
	Teachers	257	8.0661	1.00	10.00
	Total	1524	7.7343	.00	10.00
To ensure we are able to inculcate the interest on biotechnology among our children	Public	105	6.0381	.00	10.00
	Public + Carnival	245	5.6612	.00	10.00
	School Students	410	7.2976	1.00	10.00
	Students + Carnival	109	6.5963	1.00	10.00
	university students	398	6.3492	1.00	10.00
	Teachers	257	7.6770	.00	10.00
	Total	1524	6.7139	.00	10.00
To ensure we are able to participate in government policies/direction and provide input	Public	104	5.3750	.00	10.00
	Public + Carnival	245	5.8082	.00	10.00
	School Students	410	7.1171	1.00	10.00
	Students + Carnival	109	6.4954	1.00	10.00
	university students	398	6.7186	1.00	10.00
	Teachers	257	6.5642	1.00	10.00
	Total	1523	6.5456	.00	10.00
To take advantage of the business opportunities in this sector	Public	105	5.0286	.00	10.00
	Public + Carnival	245	.2612	.00	10.00
	School Students	410	.0000	.00	.00
	Students + Carnival	109	.0000	.00	.00
	university students	398	3.2538	.00	10.00
	Teachers	257	.0000	.00	.00
	Total	1524	1.2382	.00	10.00

For a desire to make well-informed decisions on nutrition, medical needs, and environmental care, and a desire to participate in government policies/direction and provide input, school students had the highest mean with 8.3000 and 7.1171 respectively. As for desire to inculcate an interest on biotechnology among children, it was obvious that teachers had the highest mean with 7.6770. Finally to take advantage of the business opportunities in this sector, the general public had the highest mean with

5.0286, followed by university students with a mean of 3.2538. School students, students who participated at carnival, and teachers were not motivated to take advantage of business opportunities at all. This indicates that communication strategies for these groups should not have much focus on this area in order to attract their attention and interest, and to make messages relevant to them.

The UK Office of Science and Technology and the Wellcome Trust (2001) recommended that dissemination of scientific information required the identification of "hooks" that connect with people's everyday lives and concerns so their attention is attracted and information retained. Understanding the motivation of the publics to seek information on biotechnology provides these "hooks". The majority of Malaysian publics' motivation for understanding biotechnology is to enable them to make well-informed decisions on nutrition, medical needs, and environmental care. This has been an effective "hook", as the subject directly relates to everyone's life. The other areas such as inculcating interest on biotechnology among children, create an ability to participate in government policies and direction, and taking advantage of the business opportunities in this sector have to be made relevant to the public as well. Clearly, these areas have direct link to everyone's life, however, they have not been made clear enough for public realisation. This is the role communicators should play.

Table 6.15: One-way ANOVA to compare the motivation to understand biotechnology across public groups

		Sum of Squares	Df	Mean Square	F	Sig.
To make well-informed decisions on nutrition, medical needs, environmental care	Between Groups	852.667	5	170.533	25.180	.000
	Within Groups	10280.705	1518	6.773		
	Total	11133.372	1523			
To ensure we are able to inculcate the interest on biotechnology among our children	Between Groups	751.950	5	150.390	20.483	.000
	Within Groups	11145.315	1518	7.342		
	Total	11897.265	1523			
To ensure we are able to participate in government policies/direction and provide input	Between Groups	421.919	5	84.384	10.345	.000
	Within Groups	12373.660	1517	8.157		
	Total	12795.578	1522			
To take advantage of the business opportunities in this sector	Between Groups	4548.972	5	909.794	218.400	.000
	Within Groups	6323.565	1518	4.166		
	Total	10872.537	1523			

The results of the ANOVA tests presented in Table 6.15, indicated that the difference in the reasons for seeking knowledge on biotechnology are significantly different among groups.

6.7 CASE STUDY: MYBIO CARNIVAL AS A NON-TRADITIONAL APPROACH

MyBio Carnival is a non-traditional approach that incorporates biotechnology into school competitions, fashion shows, exhibitions for the public, and interactive sessions. Non-traditional approaches are not entirely new in public understanding of science. Bringing science to the public through unusual venue such as shopping malls, railway stations, cinemas, science theatres (Riise, 2006), public parks, metro stations, hospitals,

libraries and even prisons (Arcand and Watzke, 2010) has been attempted before. Tatalovic (2009) reported the use of comics as tools for science education and communication. Mitsuishi et. al. (2001) attempted the creation of a "Scientist Library" as an avenue for scientists to talk publicly about their research and about themselves personally. MyBio Carnival took a similar approach by incorporating the elements of biotechnology, communication, entertainment and school competitions. It aimed to impart knowledge on biotechnology through interactive modules and stimulation of emotions which would facilitate appreciation and understanding of biotechnology, and get an opinion of it. This resembled the contextual approach where two-way communication takes place between the public and the scientific community. The main target audience for MyBio Carnival were students (schools and universities), teachers, parents and the general public. General public (n=245) and secondary school students (n=109) were the visitors at MyBio Carnival. MABIC described the MyBio Carnival as:

> *"The Carnival was a platform to provoke interest on the part of youngsters to study biotechnology and take a keen interest in this field. It exposed them to the various fields in biotechnology, their potentials, career opportunities, and issues involved in this industry. The carnival was also an ideal venue for family outings. It created opportunities for parents to be involved with their children, thus 'forcing' parents to take interest in this subject."(MABIC)*

The components of MyBio Carnival are discussed here.

6.7.1   Activities

Schools Competitions

Debate, quiz, spelling, poster drawing, essay writing, and public speaking competitions were organised for both primary and secondary school students. This was done in collaboration with the Ministry of Education, which took the responsibility of publicising the competitions and endorsing the certificates of participation. The certificate from the Ministry of Education was a great incentive for students to take part.

The poster drawing competition was opened to both primary and secondary schools, whereas, the quiz, spelling, essay writing and public speaking competitions were only for secondary schools. The debate was organised for secondary schools and universities. Topics for all competitions revolved around biotechnology, its policies, economic impact, industry, ethics, and national and global status. An estimated 500 students took part in all the competitions each year (2010 and 2011). Through these competitions, participants were able to collect information, analyse it, and translate it into knowledge. Students were thus, exposed to biotechnology outside the classroom setting which enhanced the learning process.

Interactive Sessions

Interactive sessions were also organised with talks by scientists, exhibitions, and hands-on experiment session. Exhibitions booths by industry, universities, and research institutes displayed various research through easy-to-explain posters and products. Brief talks were given by scientists and industry experts on various subjects such as agricultural biotechnology, mushroom cultivation and medicinal use, GM technology, and medical biotechnology. Public education was fostered through play, hands-on experience, and interaction with peers and experts without the formality of the classroom and rigidness of a structured learning process. Biotechnology was thus introduced as a "fun" and pragmatic science rather than a field difficult to understand. Dubbed as "BioWonders", the interactive and hands-on sessions included DNA extraction using household materials such as alcohol, meat tenderizer, baking soda, salt and detergent. Other sessions included building a DNA model, observing microbes under the microscope, and preparation of yogurt. Informative displays and exhibitions by biotechnology companies, universities and research institutes became an effective

didactic instrument to interpret biotechnology and explain to the public what takes place in the laboratories.

Fashion Show and Design

The fashion design competition and fashion show was organised among professional and student designers. This was aimed to link biotechnology and entertainment to gain public and media attention. Informal education experiences have strong non-conceptual and non-verbal component, and quite emotional, aesthetical, motivational and social outcomes (Rodari, 2009). This was the case with incorporating biotechnology into fashion. It also managed to reach out to unusual target audiences - the fashion fraternity and women. The designers designed fabrics based on biotechnology motifs. DNA, plasmids, Dolly the sheep, bacteria, viruses, algae and seaweed, fungi, and chromosomes were some of the popular designs. Media coverage on the fashion show was good with three news items in the newspapers - *New Straits Times* and *The Star*, four television talk shows, and one item of radio coverage. And more importantly, for the first time, biotechnology was published in the fashion pages of newspapers. This initiative managed to engage the greater public, where most of them had previously only had the slightest knowledge and interest on this subject. This is similar to Tatalovic's (2009) argument for using comic as tools for science education and communication. He argues that since comics are part of popular culture, it allows them to reach many people of various backgrounds who might not otherwise be reached. The same can be said for fashion as a biotechnology education tool.

Public Feedback on MyBio Carnival

The impact of MyBio Carnival was evaluated both quantitatively and qualitatively.

Below are some of the feedbacks received from participants of the carnival:

"We learned a lot (about biotechnology) and had a new topic to talk about. We had to devote a week of preparation by doing research on the Internet prior to the debate. There's so much information available but we have to make sure it is accurate." – Debate participant (Secondary school student)

"I never liked science, but now my perspective changed. I see how biotechnology can improve productivity." - Debate participant (Secondary school student)

"Now we know what biotechnology is and how interesting it is as a field of study. Initially we were concerned only about concepts and technical information. But reading about the topic enabled us to appreciate what scientists are doing and what we can expect from their research. We learned about what the technology can do to improve the quality of living." – Quiz participant (Secondary school student)

" We learned to spell words associated with biotechnology. In addition, we got new terms needed for a better understanding of what the science is all about." – Spelling participant (Secondary school student)

"I can express my thoughts through the use of colours. I can show how biotechnology affects people." – Poster drawing (Secondary school student)

" As judges, we were overwhelmed by the number of students who joined the contest. They ranged from very young primary pupils to secondary school students. We were impressed by how students managed to interpret biotechnology according to the theme given." – Judges for poster drawing competition

"Fashion and science are seen as two extremes with no meeting points. Never in my mind have I ever thought that the two could merge." – Fashion student (Age: 21)

"In fashion, we translate shapes and colors into meaningful designs. It's something beyond our imagination to have biotechnology as an inspiration to create fashion design. But we did it and learned a lot." – Fashion student (Age: 22)

"I saw a DNA for the first time. I felt like a real scientist." - Participant of BioWonders (Student, age: 10)

"My interest on biotechnology increased drastically, especially for someone who knew nothing about it before the carnival." (Carnival participant)

"The competition made me do research on biotechnology topics. I did not know anything about it, but now I can talk about it a little." - Essay writing participant (Secondary school student)

"The inclusion of fashion design in this carnival made us read about biotechnology. We were totally remote from this subject and it never triggered our interest. But now we have started to read about biotechnology. We are able to discuss biotech now." (Fashion lecturer)

6.7.2 Feedback on MyBio Carnival as a Non-Traditional Approach to Communicate Biotechnology

Table 6.16: The frequency of respondents' feedback on the effectiveness of MyBio Carnival as an effective approach to create public awareness of biotechnology

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	191	54.0	54.0	53.7
No	15	4.2	4.2	57.9
Moderately effective	148	41.8	41.8	99.7
Total	354	100.0	100.0	100.0

As results presented in Table 6.16 shows, a majority of respondents (54%) concurred that the carnival was an effective approach to create public awareness about biotechnology. Those who agreed that the carnival was moderately effective consisted of 41.8 per cent of the respondents. Only 4.2 per cent did not agree that carnival was effective.

Table 6.17: The frequency of respondents' feedback on the understanding of biotechnology after the visit

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	180	50.8	50.8	49.7
No	31	8.8	8.8	67.2
Moderately effective	143	40.4	40.4	99.5
Total	354	100.0	100.0	100.0

When asked if their understanding of biotechnology improved after the visit to the carnival, a majority of the respondents (50.8%) indicated that their understanding was improved. Another 40.4 per cent indicated that their understanding had moderately improved and a small minority, 8.8 per cent, indicated that the carnival did not make any difference.

Table 6.18: The frequency of respondents' feedback on making the carnival an annual event

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	339	95.8	95.8	95.6
No	15	4.2	4.2	99.7
Total	354	100.0	100.0	

When asked if the carnival should be made an annual event, a majority of respondents (95.8%) said Yes, and 4.2 per cent said No.

Table 6.19: The frequency of respondents' feedback in comparing the effectiveness of the carnival to newspapers, TV, radio and internet

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	177	50.0	50.0	49.7
No	25	7.1	7.1	56.3
Slightly better	152	42.9	42.9	100.0
Total	354	100.0	100.0	

When asked if the carnival was more effective than newspapers, TV, radio and internet in creating public understanding of biotechnology, 50 per cent of the respondents said "Yes", and 42.9 per cent said "Slightly better". Whereas, only 7.1 per cent said all other media were better.

Table 6.20: Descriptive analysis on the effectiveness MyBio Carnival activities

		N	Mean	Std Deviation	Std Error Mean
Poster drawing	Public + Carnival	245	6.1070	2.23719	.14352
	Students + Carnival	109	6.0642	2.99776	.28713
Essay writing	Public + Carnival	245	6.6667	3.13735	.20126
	Students + Carnival	109	6.8349	2.76390	.26473
Colouring	Public + Carnival	245	4.6831	1.94618	.12485
	Students + Carnival	109	4.8532	2.81144	.26929
Spelling Competition	Public + Carnival	245	5.1358	2.05756	.13199
	Students + Carnival	109	6.0183	2.77216	.26929
Quiz	Public + Carnival	245	6.0000	4.33895	.27834
	Students + Carnival	109	7.3119	2.76451	.26479
Fashion show	Public + Carnival	245	5.0412	2.17953	.13982
	Students + Carnival	109	5.1193	3.01762	.28904
Debates	Public + Carnival	245	7.0617	2.00627	.12870
	Students + Carnival	109	6.6147	3.18825	.30538
Exhibition	Public + Carnival	245	6.9918	1.99170	.12777
	Students + Carnival	109	7.2018	2.64498	.25334
Hands-on experiments	Public + Carnival	245	6.8971	1.86799	.13667
	Students + Carnival	109	6.5413	2.64061	.25292
Talks	Public + Carnival	245	6.8971	1.86799	.13667
	Students + Carnival	109	6.3211	2.68356	.25704

Based on the evaluation given by visitors to MyBio Carnival, there was agreement between the public and school students on the three least effective activities, which were Spelling, the Fashion Show, and Colouring. However, the fashion show received thumbs up from fashion students and lecturers, but was not an effective tool for the general public. It successfully engaged the fashion fraternity, who were a distant audience of biotechnology, and it gave them an opportunity to take an interest in this subject, as the show and design competition required them to do some research in order to design their outfits based on biotechnology motifs.

The exhibition was ranked as the second most effective tool by both the public and school students. School students found the quiz to be most effective (mean 7.3 out of total score of 10). Essay writing and debate were also quite high in ranking among school students with means of 6.8 and 6.6 respectively (out of total score of 10). Debate (mean score of 6.6), hands-on experiments (mean score of 6.5), and talks (mean score of 6.2) came fifth, sixth and seventh, but with not much difference in mean scores. It could be concluded that quiz, exhibition, essay writing, debate, hands-on experiments, and talks were all effective approaches for school students, which was also shown by the feedback given by some students on these activities. All these competitions required students to undertake heavy research on biotechnology topics and to be well-informed on this subject. Thus, the competitions served as a good exercise to help students take a keen interest on this subject and enhance their understanding.

Though the public did not participate in the school activities, they ranked the debate as the most effective approach (mean score of 7.0). Hands-on experiments and talks were equally ranked the same (mean score of 6.8), whereas essay writing and poster drawing were given 6.6 and 6.1 mean scores respectively.

On the whole MyBio Carnival was judged an effective approach for public understanding of biotechnology. The positive feedback from participants and the quantitative study showed that the carnival was an effective tool to reach to a wider audience. It revealed that the carnival exposed the general public, especially students to biotechnology and triggered their interest to learn more about the subject. A number of carnival activities used visual approach such as poster drawing, fashion, colouring, and DNA extraction, which were effective in arousing participants' interest. Visual imagery is recognised as being a more powerful means of communicating with the public than

verbal description (Bourgery and Guimaraes, 1993). Although the carnival is a good vehicle to convey messages on biotechnology, the long-term effect of the carnival could not be assessed. A follow-up study is needed to measure the retention rate of the participants' interest.

However, the activities were also shown to be audience-specific. The fashion show and design competition was effective for fashion students and not for school students and the public, while public preferred exhibitions, hands-on experiments and talks, whereas quiz, exhibition, essay writing, debate, hands-on experiments, and talks were effective for school students. Findings of t-test analysis in Table 6.20, indicated on the statistically significant differences for spelling competition, (t= -2.97, P≤.00) and for quiz, (t=-2.9, P≤.00) and for talk, (t=1.97, P≤.00) between students and public participants in carnival activities respectively.

Table 6.21: t-Test for effectiveness MyBio Carnival activities between public participants and students participants

	Levene's Test for Equality of Variances		t-test for Equality of Means		Sig. (2-tailed)
	F	**Sig.**	**T**	**df**	
Poster drawing	22.736	.000	.149	350	.882
			.133	164.131	.894
Essay writing	2.704	.101	-.482	350	.630
			-.506	234.029	.613
Colouring	27.603	.000	-.656	350	.512
			-.573	156.197	.567
Spelling Competition	19.179	.000	-3.326	350	.001
			-2.976	163.514	.003
Quiz	1.552	.214	-2.902	350	.004
			-3.415	309.755	.001
Fashion show	33.115	.000	-.274	350	.784
			-.243	160.535	.808
Debates	50.313	.000	1.594	350	.112
			1.349	147.694	.179
Exhibition	16.308	.000	-.823	350	.411
			-.740	165.157	.460
Hands-on experiments	17.913	.000	1.445	350	.149
			1.271	158.366	.205
Talks	10.401	.001	2.158	350	.032
			1.979	171.579	.04

6.8   CONCLUSION ON MALAYSIAN PUBLICS

This research yielded preliminary information that alerts biotechnology communicators to some specific information needs and attitudes of the publics. There was limited previous research on the areas covered in this research as most previous research focused on the public's opinion on how they perceive biotechnology (whether in a positive or a negative manner) and on how the media and other sources of information influence their perceptions. However, for Malaysia, basic information that is covered in this area of research is a prerequisite before we can study public perception and media framing, looking at whether the media gives prominent coverage to biotechnology,

whether the public is satisfied with the prominence given to biotechnology by the media, and who do the public trust most? The public is not a uniform whole but is segmented by differing interests, abilities, resources, and needs (Borchelt, 2001). This information would help immensely in understanding the plurality of public interests and attitude, and influence biotechnology communication strategies.

The evidence from this research shows that 30.7 per cent of Malaysian publics rate themselves as having a good understanding of biotechnology, and 19.2 per cent rate themselves as having little understanding of biotechnology. Although these results could not be compared to the previous studies carried out by Amin (2007) due to different methodology used, the increased level of awareness as indicated by Amin indicates that there is increased public understanding initiatives from various stakeholders and this could be attributed to launch of the National Biotechnology Policy in 2005, and active role played by BiotechCorp which was established as a result of the policy, as well as other NROs, and the increased centrality of biotechnology to the country's economy. From the data collected from NROs and scientists, it is evident that the combined efforts of these communicators, which cover all key target audience and objectives, lead to better understanding among the public. However, a setback might be the approach used, which is the deficit approach. Potentially a more holistic approach to biotechnology communication is one that integrates all the communication models and conventional tools such as media, and non-traditional events such as the carnival, that together creates a robust approach to effectively satisfy the publics' learning needs and facilitate active public participation.

It is also interesting and assuring to note that Malaysian publics have an interest in at least one field of biotechnology and only a minority of 7.5 per cent are not interested at all. The overwhelming public interest in the field of medical biotechnology aligns with the media's tendency to publish more articles in this field. Health and medical articles dominated the science pages of all Malaysian newspapers monitored in this research. This is consistent with other studies around the world (Bauer, 1998; Bucchi and Mazzolini, 2003; Hansen and Dickinson, 1992; Hijmans et. al.; 2003) where medical and health news is given more prominence by the media. This phenomenon is fully understood by all the journalists interviewed for this research who indicated medical news is most relevant to the general public. A challenge will be for communicators to identify ways to make other fields (agriculture, environment, and industry) relevant to the public. It must be acknowledged that there is a significant population that has interest in these areas as well and their needs should not be neglected. Agriculture and industrial biotechnology are two main thrusts of the National Biotechnology Policy (2005), thus it is important to enhance the public's interests in these areas by framing stories to align with public interests and values.

Deciding the most effective channel of communication for the public presents a challenge as the public follows many different media for news and information, and their level of trust in different sources varies. Stakeholders' perceptions of the trustworthiness and credibility of institutions play a vital part in the acceptance and diffusion of new technologies (Juanillo, 2003). Analysis shows there is a general trend towards the preferred and trustworthy source of information in the USA, UK and Malaysia, which indicates using trust as a framework for media selection, and also shows the advantage of using international comparisons in this research, assessing these countries' communication strategies as models for Malaysia. As media and scientists

rank high on the credibility ladder, they should be leveraged to be champions in engaging the public in shaping public opinion and understanding of biotechnology. Although this research showed that television, newspapers and internet were the most popular source of information, the other sources (science centres, radio and family and friends) are also relevant sources where the publics seek information from. The effectiveness of public understanding of biotechnology, therefore, is greater when multiple channels are engaged in the dissemination of information about biotechnology, which has also been suggested by Field and Powell (2001). The solution might be to understand the different target audiences and their preferred choices, and also enhance the effectiveness of the less popular sources such as radio and science centres.

While a strategy of concentrating only the most popular and trusted media might be cost-effective, it fails to take advantage of the complexity of media that different target audiences use, and the risks isolating some segments of the public. A multiple-media strategy to reach multiple audiences will also be more adaptable to changing media consumption trends. Since radio has been identified as the least satisfactory in terms of coverage on biotechnology, more efforts should be taken by relevant authorities such as Ministry of Information or Ministry of Science, Technology and Innovation to beef up radio's role in public understanding of biotechnology, rather than to ignore it. It must be acknowledged that there are sectors of the public to whom radio is still the main source of information, and with the increasing number of radio stations in Malaysia, and special stations for women and youth, the number of listeners is on the rise (Nielsen's Radio Audience Measurement, 2011). There are 19 private and 34 government-owned radio stations in Malaysia (Ministry of Information, Malaysia). According to Nielsen's Radio Audience Measurement (2011) survey, nine out of 10 consumers in Peninsular Malaysia aged 10 and above listen to radio. According to this survey too, Malaysians

are tuning into radio network for 21 hours and 34 minutes in a week, making them the most avid radio listeners in Asia-Pacific region. German playwright Bertolt Brecht's frequently cited commentary on radio further strengthens the role of this media:

> *"Radio should be converted from a distribution system to a communication system. Radio could be the most wonderful public communication system imaginable, a gigantic system of channels – could be, that is, if it were capable not only of transmitting but of receiving, of making the listener not only hear but also speak, not of isolating him but of connecting him." (Brecht, 1979/80)*

As this media is underutilised by biotechnology communicators it could be turned into a more effective channel for biotechnology communication.

Another important aspect of the biotechnology communication strategy is the motivation for the public to understand biotechnology, which is generally reflected in the relevance of the subject to people's everyday life. The most important motivation for Malaysian publics to understand biotechnology is to be able to make well-informed decisions on nutrition, medical needs, and environmental care. Falchetti et. al. (2007) observed that the questions that are important to people are primarily concerned with everyday life and with the education-acquired personal knowledge. Therefore what scientists define as "hot topics" might not have a meaningful place in knowledge representations of the audience. The second important motivation for Malaysian public to understand biotechnology is to be able to inculcate the interest on biotechnology among our children, again a reason with personal relevance. Therefore, it is important for biotechnology communicators to understand the publics' motivation to ensure their messages are crafted in a way that is relevant to the audience. Though the other reasons have impact on the publics' life such as ensuring government sets the right research and funding priorities, and taking advantage of business opportunities, they are probably not obvious enough to the public. The public need to be sensitised on these issues to create

a more science-literate society who will be willing to take part in discussions on the future of biotechnology in Malaysia.

In short, it is not the aim of this research to strike out the unpopular media, areas of interest and topics from the biotechnology communication strategy. Rather, due to the importance and relevance of even currently unpopular media and areas of interest, biotechnology communicators should find a way to incorporate them in their communication strategy in a more effective manner. Understanding the publics' lack of interest in unpopular media helps biotechnology communicators to strengthen these areas in their strategies.

One way of doing this is through non-traditional approach where public can learn about biotechnology. The case study used in this research, which is the MyBio Carnival, proved to be an effective strategy. MyBio Carnival served as a convergence point among scientists, industry, media, policymakers, schools and the general public. It has the ability to play a role in increasing the public understanding of biotechnology and making the audience learn about biotechnology in an indirect manner. This makes the learning process fun and memorable, with a good mix of education and entertainment. All the school competitions were rated above mean score 6.00 (out of a total mean score of 10.00). The fashion show had a big impact on the fashion school where biotechnology was made one of the projects for all students, and it created a unique union between biotechnology and fashion, opening the imagination of fashion designers and making them read about biotechnology. As described by Matterson (2006), artists may see science as rich source of ideas and thinking. The carnival was overall evaluated as moderate to effective by 95.8 per cent of the visitors, moderate to effective in improving their understanding of biotechnology by 91.6 per cent of visitors, and 95.8

per cent recommended it as annual event. The carnival provided a different avenue that could complement the existing biotechnology communication strategies carried out by scientists and NROs. It brought members of the general public closer to biotechnology with education being enhanced with entertainment, in line with previous research that indicates the use of informal settings for learning activities is more likely to have positive effect on people's interests and attitudes than on their cognitive learning (Meredith and Mullins, 1997).

Nevertheless, the relatively small number of people who attended (in particular the general public) the carnival needs more analysis. The choice of venue could play an important part in attracting more participants. Perhaps, shopping malls would be a more ideal venue. The case of "Science on the Underground" project in London (Naylor and Keogh, 1999) could be used as an example, where posters based on concept cartoons to raise public interest and awareness on science was posted on the advertising space on railway carriages. Like the train stations in the UK, shopping malls in Malaysia is one of the possible means to get captive audience. According to a report by PricewaterhouseCoopers (2005-2006), Malaysians have a strong shopping fetish, especially during the weekends and on public holidays. This has given rise to, Malaysian shopping malls that are not only shopping havens but also entertainment hubs with mini-cinemas, ice-skating rinks, bowling alleys, indoor theme parks, 3-D theatres, etc. For this reason, there are advantages in the use of shopping malls as venues for events such as the carnival where members of the public are likely to come into contact with biotechnology without having to make any special effort.

The results from this research show that Malaysian publics are no different from the general public in many other countries, i.e. USA and UK. They generally have a good understanding and interest in biotechnology, and use a number of information sources. This is a good platform for scientists, NROs, media and policymakers to engage with the public on biotechnology. Efforts should be channeled into getting the public interested in topics beyond their preferred choice, such as industrial biotechnology, given its priority accorded by the government. Exploiting underutilised media such as radio is another area that requires serious attention. Disinterest among the publics in influencing government policies related to biotechnology and venturing into biobusiness should be addressed as well. Otherwise, biotechnology outreach programmes would only serve as educational programmes that do not translate into public participation and economic benefits. Thus, it is important for communicators to connect awareness programmes to government policy and efforts to get public participation. Job creation and bioentrepreneurship have been priorities under the National Biotechnology Policy, which creates a strong need for the public participation and this can only be realised if there is informed citizens on this subject.